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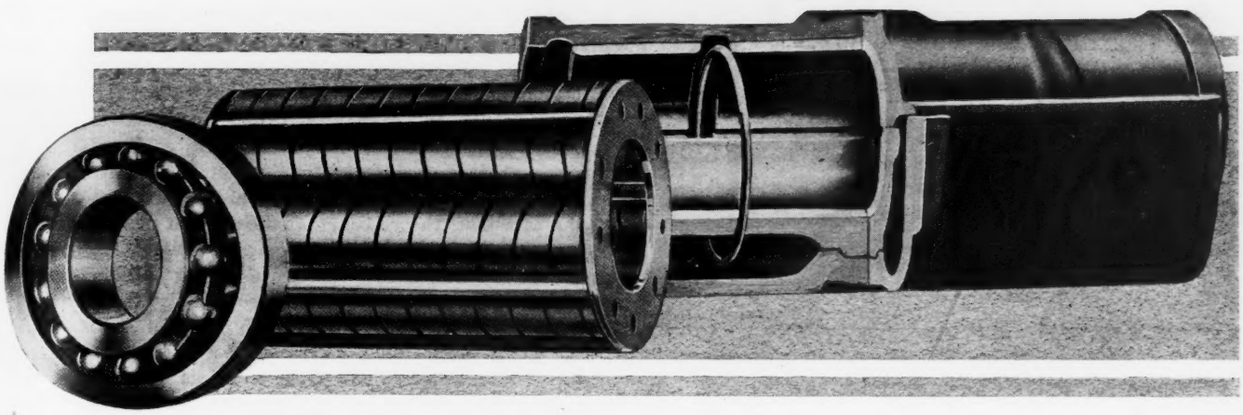

Bearings for Machine Shop Equipment

By Edward K. Hammond[1]

This is the first of a series of three articles dealing with the design of different forms of bearings used in machine shop equipment. Various forms of plain bearings which have demonstrated their ability to give satisfactory service will be illustrated and described in this installment. In the second article of this series, descriptions will be given of the different types of ball bearings and methods of designing mountings for these bearings to meet the requirements of various conditions of service under which ball bearings are used in machine shop equipment. The third and last article of the series will discuss the different types of roller bearings and explain conditions of service under which bearings of this type find successful application in the machine shop.

IN working out the design of journal bearings for use on any type of machine it is necessary for careful consideration to be given to the conditions of service under which each bearing will operate. This is particularly true in the case of bearings used on machine tools, because there is a great amount of variation in the conditions which machine tool bearings are required to fulfill. In bearings for driving shafts, provision made for the efficient transmission of power and freedom from wear are usually the two points of maximum importance; but in the main spindle bearings, these important points may only receive consideration after provision has been made in the design to assure obtaining a bearing which will be a tight running fit when new and in which means are provided to compensate for any wear that may develop after the machine is placed in service. Lost motion in a spindle bearing will show itself by the presence of chatter marks on the work and by difficulty experienced in holding dimensions of the work within the required limits of accuracy. On this account, the designer of machine tool spindle bearings must first consider the conditions under which the bearings are to operate with the idea of fulfilling these requirements without tendency for the bearings to wear excessively.

After this has been done, it is necessary to take steps to work out the design along such lines that convenient means are provided for readily taking up any small amount of wear which may develop in the bearings. Only after provision has been made for maintaining an accurate fit between the spindle and its bearings can the designer turn his attention to the question of transmission efficiency, although this condition must also be fulfilled. There are often special conditions which must be considered in designing bearings in order to assure satisfactory operation. For instance, on grinding machines, trouble would almost surely be experienced through abrasive dust from the wheel finding its way into the bearings and causing them to wear excessively, unless the housings were designed with special provision to exclude dust and other foreign matter from the bearings. This is one typical example of the special conditions which are likely to require careful consideration in working out the design of bearings capable of giving satisfactory service.

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Types of Bearings Used in Machine Shops

In taking up this discussion of the different types of journal bearings used in machine shop equipment, there are three classes of bearings which will receive consideration. These are: (1) Plain bearings, which may be made of bronze, babbitt, cast iron, etc.; (2) ball bearings; and (3) roller bearings. Naturally, there are many variations in the design of each of these classes of bearings, which have been worked out by different manufacturers to meet the requirements of various conditions of service. After giving a general description of the different types of bearings and the peculiar advantages of each type for those especial classes of service in which it finds successful application, a description will be given of the modifications in design which have been worked out to meet the requirements of individual classes of service, and in connection with these detailed descriptions, information will be presented concerning various methods of mounting the different types of bearings in machine tools, countershafts, lineshaft hangers, etc., and of the means provided for excluding foreign matter which would tend to abrade the bearings if it found its way between the rubbing surfaces.

Characteristics of Plain Bearings

There are a great variety of plain bearings which have been developed to meet the requirements of different conditions of service under which shafts and spindles are required to operate. In all plain bearings there is surface contact between the shaft and the bearing, and in order to provide for the efficient transmission of power without excessive frictional resistance, wear, and tendency of the bearing to give trouble through heating, it is a matter of general knowledge that a constant supply of clean lubricating oil must be delivered to the bearing, and that this lubricant must be suitable for the conditions of bearing pressure, speed of rotation, etc. The effect of a lubricant is to prevent direct metal-to-metal contact, and some authorities explain this action by comparing the lubricant to the balls in a ball bearing. Where this comparison is made, it is justified on the basis that the lubricant consists of a multitude of small globules of oil which roll between the shaft and its bearing, thus preventing metal-to-metal contact and greatly reducing frictional resistance. In any case, this is the function of the oil film, although whether the globules of oil provide

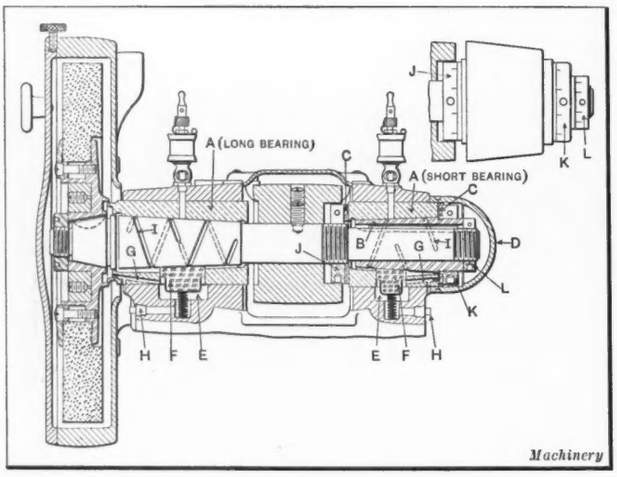

Fig. 1. Design of Spindle Bearings for External Grinding Machine, showing Provision made to compensate for Wear and Method of Lubrication

a true rolling action is largely a matter of hypothesis. Plain bearings are made in a great variety of designs, according to the conditions of service under which they operate; but, as a rule, when bearings of this type are used to support the spindles of machine tools, where the presence of any considerable amount of lost motion would result in inaccuracy of work produced by the machines, means of adjustment are provided to take up any lost motion that develops as a result of wear in the bearing. In the detailed descriptions of different types of plain bearings, which will be given in the following section of this article, an explanation will be presented of the manner in which designers have worked out means of compensating for wear.

Application of Ball Bearings

It was first demonstrated that ball bearings possessed features of practical value at the time that bicycle riding was the vogue. Ball bearings used in bicycles showed conclusively that they were the means of greatly reducing frictional resistance, thus making the operation of the machine far easier. These bearings were of what is commonly known as the "cup-and-cone" type, in which provision was made for adjusting the bearing to regulate the amount of space left between the races to receive the balls. The great weakness of this form of bearing design was that adjustment of the bearings on a bicycle was frequently made by men who had little knowledge of the actual requirements which had to be fulfilled, with the result that the bearings were either adjusted too tight or left too loose; and in either case this was likely to result in an excessive amount of wear, which soon destroyed the usefulness of the bearing. This tendency of the old style of "cup-and-cone" ball bearing used on bicycles to wear out, due to improper adjustment, created an impression among builders of machine tools that a comparatively short operating life was one of the serious limitations of ball bearings. Unfortunately, this impression was considerably strengthened through a similarly limited amount of service secured from ball bearings which were designed and made in the shops of machinery builders by men who had only a very limited knowledge of the requirements which must be fulfilled in order to obtain a ball bearing capable of standing up under the required service.

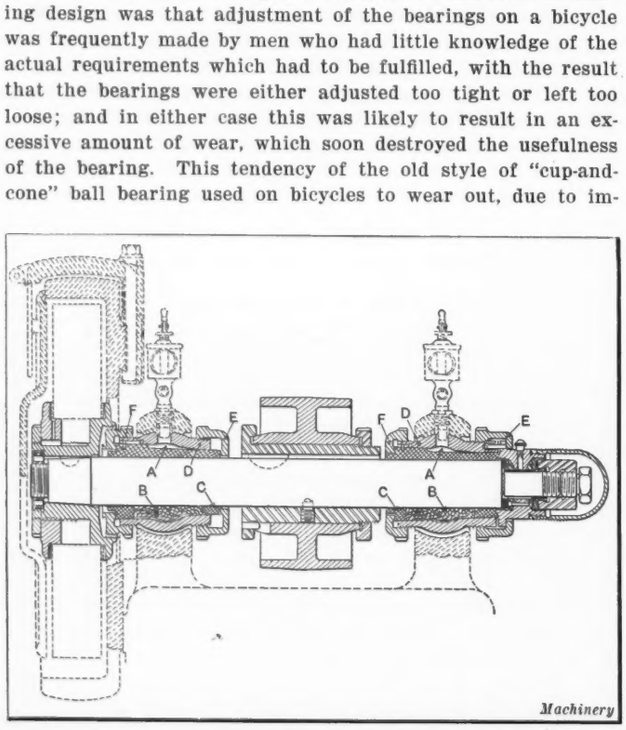

Fig. 2. Another Example of Grinding Machine Spindle Bearing Construction. These Bearings have Means of Compensation for Wear, and the Spherical Seats make them Self-aligning

It was generally conceded by those who experimented with the use of ball bearings that until the bearings started to wear their efficiency in the transmission of power was far in advance of that secured with any form of plain bearing. This high transmission efficiency is due to absence of friction, owing to the fact that, theoretically, there is point contact between the balls in the bearing and the races in which they run, so that the only frictional resistance is that resulting from the rubbing action of the balls on the retainer which distributes them uniformly in the bearing. As a matter of fact, this theory is not quite borne out in practice, because no material is inelastic, and although the steel from which the balls and races of a ball bearing are made is carefully heat-treated to give it the most desirable physical properties, the load on the bearing results in compressing the balls and pushing them slightly below the surface of the races surrounding the points of contact. As a result, there are small surfaces of contact between each ball and the inside and outside races, but these surfaces are very small, so that the balls can roll in the bearing with little frictional resistance.

When the automobile industry began to develop, there came a greatly increased demand for high-grade ball bearings, with the result that this matter was taken up by men of sufficient mechanical and scientific training to enable them to find out definitely the conditions which had to be fulfilled by a high-grade ball bearing in order to enable it to give efficient service over a long period of time. These men were so successful in their work of developing ball bearings to a point where they are of practical value that it is now a recognized fact that almost an absolute freedom from wear is a feature of ball bearings, which is of equal importance with their ability to transmit power with a high degree of efficiency. When it was demonstrated that ball bearings had been developed to a point where they were able to stand up under the conditions imposed upon them in automobile service, builders of machine tools began to see the desirability of applying bearings of this type in order to secure the double benefit of freedom from wear and high efficiency in power transmission.

Use of Ball Bearings in Machine Tools

It will be of interest to note that one of the first successful applications of ball bearings in machine tool construction was to support the thrust of drilling machine spindles. In this service they gave very satisfactory results, and now practically all high-grade drilling machines are furnished with ball bearings to carry the thrust load. Both radial and thrust ball bearings are employed in some cases for supporting the spindles of other types of machine tools besides drilling machines; and ball bearings are also quite generally used in machine tool gear-boxes, countershafts, lineshaft hangers, and in many other places in the machine shop. In order to give satisfactory service, these bearings must be made of the proper quality of steel, and the necessary care must be taken in their production so that the surfaces of both balls and races are free from even the slightest surface defects; the steel must also be of the proper quality and carefully heat-treated to give it the desired physical properties. Ball bearings must also be properly mounted in housings which are so designed that they exclude all dirt and grit from the bearing.

Last, although by no means least, the races and balls must be accurate to 0.0001 inch, because, if this degree of precision is not obtained, there will be a tendency for the load to concentrate on a few balls in the bearing, instead of having this load distributed over all the balls. When such a condition exists, it is quite natural that those balls subjected to an excessive load may start to wear—and the same is true of ball bearings where any surface defects may cause wear to

start. Those who have had experience in the use of ball bearings accept it as a demonstrated fact that when wear once starts in a ball bearing, the bearing will deteriorate very rapidly to the point where it is no longer capable of giving efficient service. Accepting this fact, the machine tool builder who is about to adopt the use of ball bearings in his product should be very careful to investigate the quality of the bearings which he proposes using, in order to make sure that they come from a manufacturer who is able to turn out satisfactory bearings and who has the reputation of turning out a product of uniformly high quality. Such ball bearings will give an ample amount of service before showing any signs of wear.

Features of Roller Bearings

Roller bearings are made in various types, in some of which the rollers are straight, while in others they are tapered; also, some types of roller bearings have solid rollers, while in other cases the rollers are made of a piece of steel rolled up into a spiral form which somewhat resembles a helical spring. It is claimed for bearings with rollers of the latter type that, in the event of a sudden increase in load, the shock is absorbed by compressing the rollers without danger of damaging the bearing. Some types of roller bearings with tapered rollers are provided with means of compensating for wear of the rollers and races. Bearings with tapered rollers are also usually capable of carrying some thrust load in addition to the radial load. In any type of roller bearing, the higher transmission efficiency of a roller bearing, as compared with that of a plain bearing, is due to the fact that, theoretically, there are only two lines of contact between each roller and the inner and outer races, respectively, instead of a considerable amount of surface contact between the bearing and the shaft or spindle which rotates in it. Actually, there is a small surface contact between each roller and the races in which it runs, due to the fact that the steel is slightly compressed and distorted through application of the load; but as this distortion is very slight, the area of the surfaces in contact with each other, and the amount of frictional resistance, is considerably less than that which exists in a plain bearing, although the transmission efficiency of roller bearings is not usually as high as that of ball bearings.

Plain Adjustable Bearings for Machine Tool Spindles

In designing the bearings for carrying the spindles of machine tools, it is of absolute importance to develop a construction which will provide means of constantly maintaining a tight fit between the spindle and its bearing boxes, in order to effectually eliminate chatter and vibration. A very little thought will make it obvious that any lost motion in the bearings will result in seriously affecting the accuracy of work produced on the machine and the perfection of finish which it is possible to obtain on the work. Not only must the bearings be a perfect fit at the time the machine is new, but provision must also be made to readily compensate for any wear which develops after the machine is placed in service, so that it will continue to produce work of the required degree of accuracy. To meet the requirements of this service, some form of tapered bronze bearing has been quite generally adopted as a standard spindle bearing construction, although various modifications of this general form of design have been worked out by different machine tool builders to provide for making the adjustment for wear which becomes necessary from time to time. These modifications may be made to meet the requirements of different conditions of service for spindles which are mounted in a vertical or a horizontal position, or they may be worked out simply to meet the individual opinions of different designers. In the following discussion, there are presented descriptions and illustrations of different well-known forms of adjustable spindle bearing designs, which have been found to give satisfactory service.

Grinding Wheel Spindle Bearings

In order to give satisfactory service, the spindle of a grinding machine must rotate without an appreciable amount of vibration; otherwise chatter marks will appear on the work. It is, perhaps, safe to say that, in working out the design of the average grinding machine, more time is given by the designer in developing a satisfactory form of spindle bearing construction and in modifying this design to overcome trouble which is experienced when the first machine is placed in service than in producing satisfactory results in any other part of the mechanism. In Fig. 1 there is shown the standard type of grinding wheel spindle bearing which has been adopted for use on external grinding machines built by the Landis Tool Co., of Waynesboro, Pa. The bronze bushings *A* are assembled in the housings in such a way that expansion and contraction, due to changes in temperature, do not in any way affect the transmission efficiency of the bearings; and compensation for wear provided by the tapered form of the bushings enables all lost motion to be taken up, thus effectually eliminating vibration and enabling the grinding machine to produce perfectly accurate work. Attention is called to the fact that adjustment for wear in the front and rear spindle bearings is made independently, so that if only one bearing

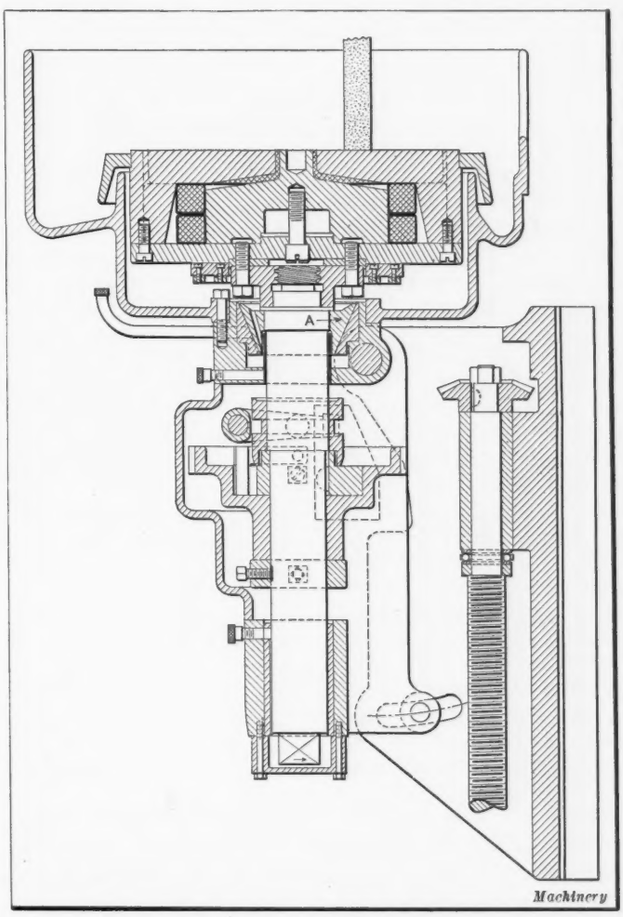

Fig. 3. Bearing for Table of Rotary Surface Grinding Machine, showing Method of automatically compensating for Wear

requires adjustment, this can be done without touching the other bearing. On these bearings, lubrication is provided by individual sight-feed oil-cups, from which a supply of oil is delivered to a reservoir *E* beneath each of the bearings. Felt wicks take oil from these reservoirs and carry it up to the bearings, the wicks *F* being held in contact with the bearings by means of compression springs. It will be seen that each reservoir is provided with a threaded plug *H*, which may be removed to drain out dirty oil and flush the bearing with kerosene before the plugs are replaced and a fresh supply of lubricating oil is delivered to the reservoir. Drains *G* are provided to prevent the possibility of reservoirs *E* overflowing and flooding the bearings. Oil-distributing grooves *I* are cut in the journals to facilitate the uniform distribution of oil. The way in which these spindle bearings are adjusted will doubtless be apparent from the illustration. Bronze bushings *A* are a press fit in the housings, and journal sleeve *B* is fitted over the back end of the spindle. The thrust load is carried by steel thrust washers *C*. When it is necessary to compensate for wear in the journal bearings, this is done by

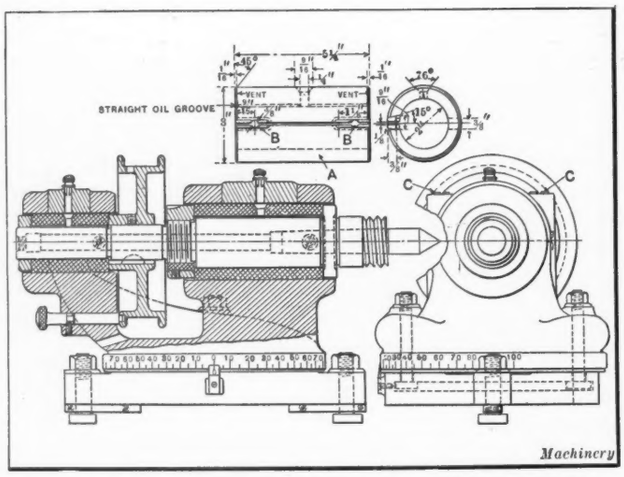

Fig. 4. Straight Cylindrical Spindle Bearings provided with Means of compensating for Wear

releasing collar *J* and tightening *L* to draw the front bearing into its box to take up lost motion; similarly, lost motion in the rear bearing is taken up by releasing collar *K* and tightening *L*, which forces sleeve *B* into the tapered bronze box. Each division on collars *J*, *K*, and *L* gives 0.00052 inch of adjustment on the diameter of the bearings.

Self-aligning Spindle Bearings

Features of particular interest in connection with the design of bearings for the wheel-spindle of a Brown & Sharpe grinding machine, shown in Fig. 2, are the provisions made for lubrication and for the automatic alignment of the bearings with each other. It will be seen that a sight-feed oil-cup is provided at the top of each bearing housing, from which lubricant is delivered to the annular channel *A* cut in the inside of sleeves *D*. Oil runs around this channel and is absorbed by a felt packing or wick *B*, which is contained in a slot cut through the bronze bearing box on the under side of the shaft. This felt packing is kept constantly saturated with oil, and is held against the shaft by a flat spring. As the shaft revolves in the bearing box, the felt distributes a uniform film of oil over the shaft, thus efficiently lubricating the bearing.

In order to assure accurate alignment between the two bearings, it will be seen that each of the bronze boxes *C* is carried in a sleeve *D* that is machined to a spherical form on the outside in order to fit into a corresponding spherical seat in the bearing housing. When a straight shaft is put through bronze bearing boxes *C*, it will be apparent that the bearings will align themselves accurately on account of the ability of the spherical seated sleeves *D* to move as required in the bearing housings. It will be seen that the bronze bushings *C* in these bearings are tapered on the outside and bored straight on the inside; this is not quite so usual an arrangement as that of bronze boxes which are bored to fit a tapered journal on the shaft they are designed to carry. These boxes *C* are split, and in order to compensate for wear, it is necessary to push the tapered outside surface of the box into the tapered seat in sleeve *D*. The boxes and adjusting nuts have beveled ends to keep the bearings expanded in sleeves *D*. First nut *E* is loosened, and then nut *F* is tightened sufficiently to force the bronze box into sleeve *D* and cause it to contract in a way which is made possible by the split construction. After the desired adjustment has been obtained by tightening nut *F*, nut *E* is again tightened against the opposite end of the bearing box, thus locking the box securely against further end movement.

Self-adjusting Vertical Bearing

The upper bearing for the table or chuck of rotary surface-grinders built by the Persons-Arter Machine Co., of Worcester, Mass., is provided with means of automatically taking up any wear in the bearing as fast as it develops. The way in which this is accomplished will be readily understood by reference to Fig. 3, where it will be seen that steel collar *A* is shrunk onto the upper end of the spindle and that this collar is tapered on the outside to fit a bronze bearing box of corresponding form. This steel collar *A* acts as a wedge in order to keep the bearing accurately centered, although the angle is such that the bearing runs quite freely and with very little friction. There is said to be absolutely no chance for side play in this spindle bearing which would cause the work-table or magnetic chuck to get out of alignment in any direction. Collar *A* and the bronze box in which it runs are arranged to form an oil reservoir from which a constant supply of lubricant is delivered to the bearing, lubrication being facilitated by spiral grooves in the taper collar which carry the lubricant and distribute it uniformly over the rubbing surfaces.

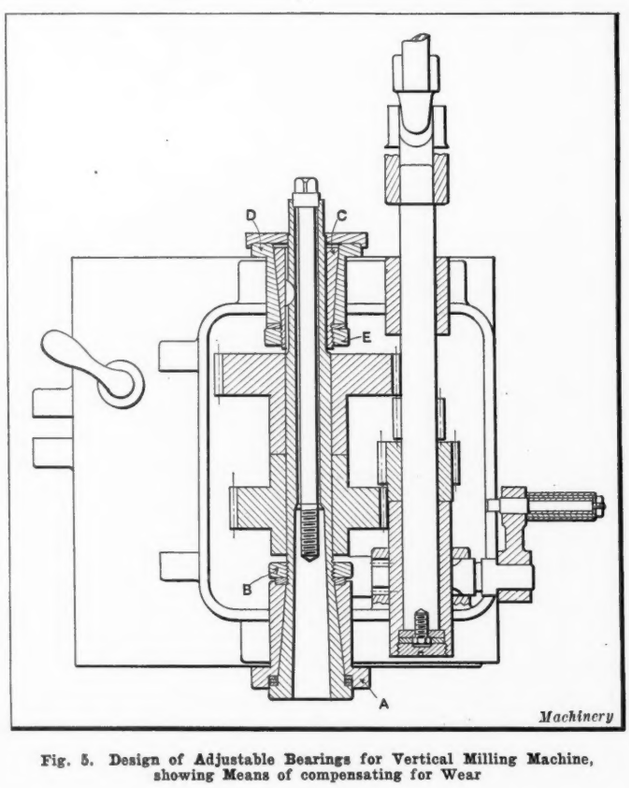

Fig. 5. Design of Adjustable Bearings for Vertical Milling Machine, showing Means of compensating for Wear

Adjustable Bearing Box of Straight Cylindrical Form

Still another form of adjustable spindle bearing box is shown in Fig. 4. This is another Brown & Sharpe construction, which has been designed for use in headstock spindle bearings. It will be seen that this box differs from any of the designs which will be shown in this article in that it is of straight cylindrical form on both the inside and outside. The method of making adjustment of the fit of this box on the spindle will be best understood by referring to the detailed view of the box shown at *A*, where it will be seen that a split extends all of the way along one side. Two dovetail slots *B* are machined in this split section to accommodate screws and beveled nuts or sleeves which may be tightened or loosened in order to expand the opening in the box or cause it to be contracted through pressure applied by the cap of the bearing housing. Reference to the end view will show that there are two

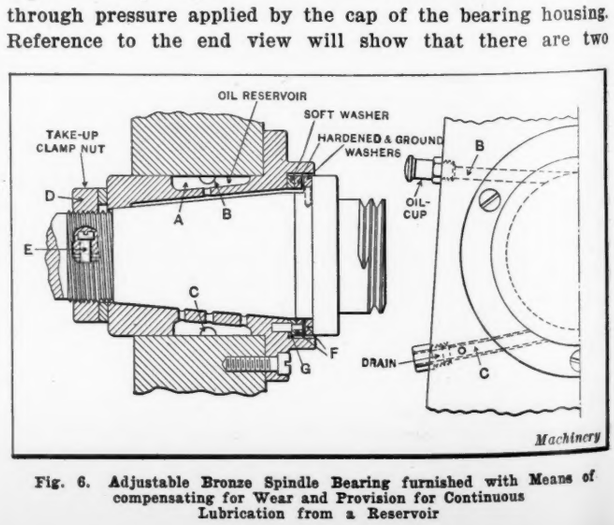

Fig. 6. Adjustable Bronze Spindle Bearing furnished with Means of compensating for Wear and Provision for Continuous Lubrication from a Reservoir

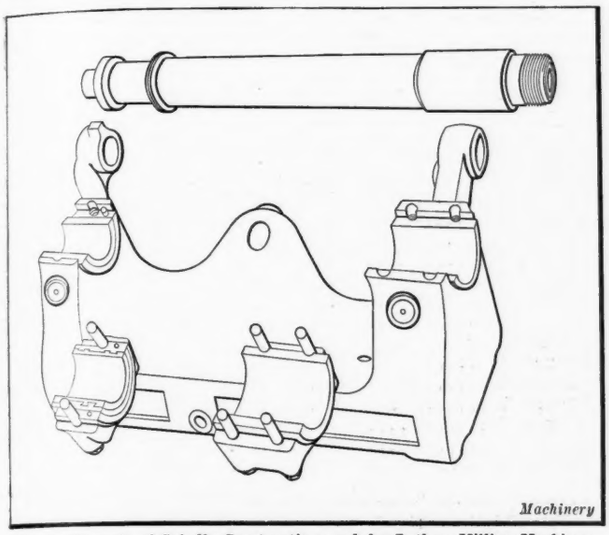

Fig. 7. Example of Spindle Construction used for Lathes, Milling Machines, and Cutter Grinders, where Front Bearing is of Chilled Cast Iron and Rear Bearing is lined with Babbitt

screws *C* which hold the cap of the bearing housing down on top of the bronze box, and when it is desired to secure a tighter fit of the box on the spindle, this result is accomplished by first backing away the screws in the sleeves in slots *B* and then tightening up the screws *C* on the cap of the bearing housing. In this way exactly the required fit for the bearing box may be obtained, and after the bearing has been in service, compensation for wear may be accomplished by further adjustment of screws *C* and the screws which adjust the sleeves fitting into slots *B*.

Examples of Milling Machine Spindle Bearing Design

For supporting the spindle of the vertical milling machine built by the Garvin Machine Co., Spring and Varick Sts., New York City, the following construction has been adopted: At the lower end of the spindle, Fig. 5, there is a bearing box *A* which is bored to a taper corresponding to the tapered journal on the spindle, in order to provide means of taking up any wear that may develop. It will be seen that the spindle is threaded along the straight portion immediately above the tapered journal to receive a threaded collar *B* which provides for holding the spindle up. When lost motion develops it is easily taken up by simply pulling the spindle up into the tapered bearing by tightening collar *B*. To provide for making this adjustment, it is necessary to face off the soft washer between bearing box *A* and the spindle flange. At the upper end, the spindle is straight and it is carried in a bushing *C* which is bored straight on the inside and turned to a taper on the outside, this bushing being secured to the spindle with a Woodruff key so that it is a tight fit. On the outside, bushing *C* is turned to a suitable taper to fit bearing box *D*, and bushing *C* is threaded at the lower end and furnished with a collar *E* which provides for maintaining a tight fit between bushing *C* and bearing box *D*. By screwing up collar *E*, provision is made for taking up any wear which develops in this bearing after the machine is put into service. It will be apparent that the use of bushing *C*, which is keyed to the spindle, is a substitute for having the journal made an integral part of the spindle, as it is at the lower end. The reason for having the upper journal in the form of a bushing keyed to the spindle is that this greatly facilitates the work of assembling the machine. Collars *B* and *E* are provided with split nuts to hold them in place after making the settings.

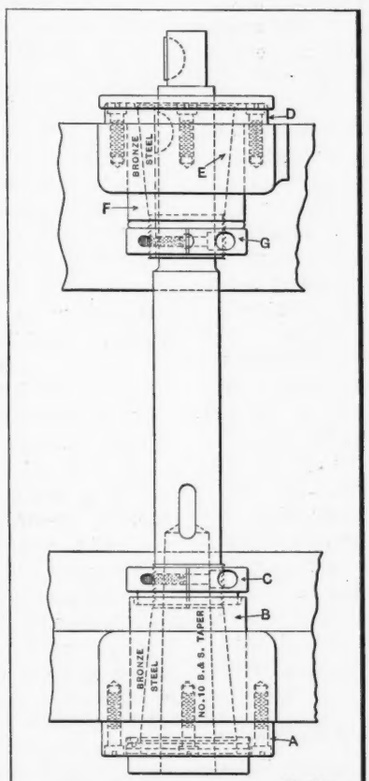

Fig. 8. Adjustable Bearings designed for Vertical Spindle Profiling Machine

Provision for Cleaning Bearings

Fig. 6 shows a form of spindle bearing construction which has been adopted as one of the standards in building machine tools made by the Garvin Machine Co. It will be apparent from the illustration that in working out this design provision has been made for supplying the bearing with lubricant from reservoir *A*, which extends around the outside of the bearing box. A supply of oil is delivered into this reservoir through tube *B* and finds its way from the reservoir to the bearing surface through holes which connect with oil-grooves cut on the inside of the bearing box. When it is desired to clean out the reservoir, this is accomplished by opening drain pipe *C* to allow the dirty oil to run out, after which the bearing is flushed with kerosene before closing drain *C* and filling the reservoir with a supply of fresh oil. It will be apparent from this illustration that the spindle is threaded on the straight portion directly to the left of the tapered journal, in order to provide for drawing the spindle into its tapered bearing box when it becomes necessary to compensate for wear. Before this adjustment can be made, soft washer *G* must be faced off. Collar *D*, by means of which this adjustment is made, is split at one side and furnished with a clamp screw *E*, so that when the bearing has been adjusted to obtain the desired fit, screw *E* is tightened to provide for clamping collar *D* firmly in the exact position to which it has been set. In most machine tool bearings, provision must be made for carrying a thrust load in addition to the normal radial load which comes on the bearing. In the present case, this result is obtained by designing the spindle with a flange at the large end of the taper. This flange bears against two hardened and ground washers *F* and a soft washer *G*, which are placed between the flange on the spindle and the end of the tapered bearing box, the thrust load being carried in this way without imposing an undue strain and unnecessary amount of wear on the bearing.

In Fig. 8 there is shown the form of adjustable bronze bearings which are used for carrying the vertical spindle of the Nos. 2 and 4 profiling machines built by the Garvin Machine Co. As in the case of the bearing design shown in the preceding illustration, it will be seen that provision is made for carrying the thrust load by having a flange at the lower end of the spindle which bears against an arrangement of thrust washers. These washers serve the double purpose of taking the thrust of the spindle and providing means of compensating for any wear and lost motion which may develop in the lower spindle bearing.

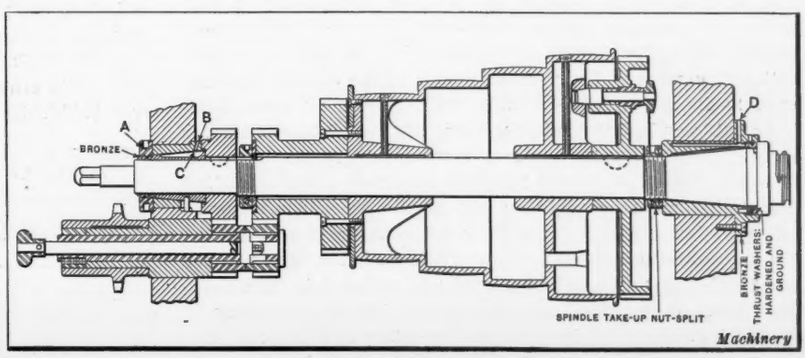

Fig. 9. Example of Bearing Design where Compensation for Wear is accomplished by compressing the Bronze Bearing Box

When wear in the bearing must be compensated for, this is done by facing off the soft thrust washer and tightening collar *C*, which is carried on the threaded section of the spindle, the result being that the spindle is drawn up into the tapered bearing box. At the upper end of the spindle there is a tapered steel bushing *E* which is keyed to the straight end of the spindle with a Woodruff key. On the outside, bushing *E* is machined to a taper to accurately fit bronze bearing box *F*, and when it is necessary to make adjustment to compensate for wear, this result is obtained by tightening threaded collar *G*. It will be apparent that both collars *C* and *G* are split on one side and furnished with binding screws to provide for securing the collars in the desired positions after the required adjustment has been made.

Compensation for Wear by Compressing Bearing Box

In Fig. 9 there is shown a different method of providing compensation for wear in a tapered bronze spindle bearing box. This construction is used on the Garvin No. 2 universal milling machines. At the front end, the spindle is furnished with a bearing box of the same general design as those which have already been described, but at the rear end, as will be seen, the bronze box is split and fitted to the straight end of the spindle, this box being tapered on the outside to engage a bushing in the machine frame with which it remains in fixed contact. Obviously, this necessitates an entirely different method of adjusting the box to afford compensation for wear, and such adjustment is obtained by tightening threaded collar *A* to provide for pulling the tapered bearing box into the bushing in the machine frame. When this collar is tightened to pull the bearing box into the tapered bushing, the bronze box is compressed against the straight journal on the spindle, thus taking up any wear which may have developed. Attention is also called to oil-hole *B*, which delivers a supply of oil into reservoir *C*, formed in this bearing box to provide a liberal supply of oil; the oil flows from the reservoir through oil-holes connecting with grooves machined in the bearing surface of the box to provide for distribution of lubricant over the bearing. The same arrangement of an oil-hole *D* and oil reservoir in the bearing box is provided at the front end of the spindle.

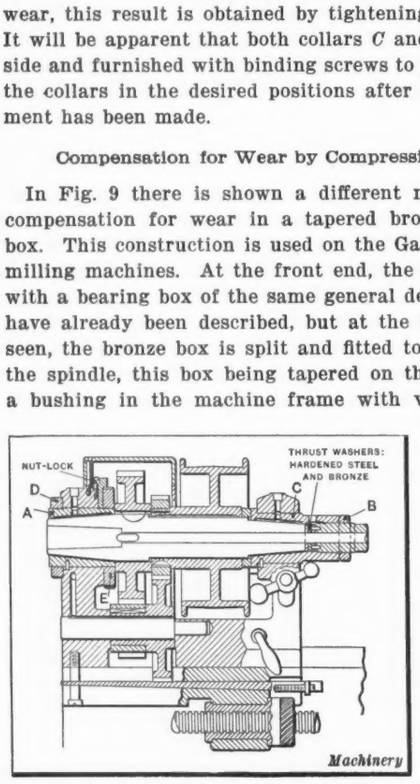

Fig. 10. Bearings designed so that Compensation for Wear is accomplished by drawing Spindle into Tapered Box

Compensation for Wear by Drawing Spindle into Tapered Box

Fig. 10 shows an example of the design of bearings for a machine tool spindle, where the journals are directly supported by tapered bronze boxes at both ends. In order to take up wear which develops in these boxes, the method of procedure is as follows: It will be seen that at the front end of the spindle (which is the left-hand end in this case) a tapered bronze box *A* is provided which is threaded on the outside at both ends. To compensate for wear which may develop in these bearing boxes, the method of procedure is as follows: Threaded collar *B*, carried at the right-hand end of the spindle, is tightened to draw the entire spindle, and hence the tapered bearing at this end of the spindle, back into box *C* to compensate for any lost motion which may have developed as the result of wear. When this result has been obtained, a corresponding adjustment must be made on box *A*, the procedure being as follows: Jam nut *B* is loosened and the rear step plug behind the nut is slacked away, after which threaded collar *D* at the front end of the spindle is loosened and collar *E* is then tightened to draw the front tapered bearing box up to a snug fit on the journal; this also pushes the entire spindle back into the rear tapered bearing *C*. When this result has been obtained, collar *D* is tightened to provide for holding the box in exactly the position in which it has been set. Then the rear step plug is carefully adjusted against the rear end of the spindle and locked by a jam nut *B*. This is another bearing design used by the Garvin Machine Co.

TABLE 1. COMPOSITION OF ALLOYS USED FOR BEARING METALS

Alloys	Lead	Tin	Antimony	Copper	Zinc	Other Constituents
Babbitt 1.....	80.0	20.0	....	....	....	.....
Babbitt 2.....	72.0	21.0	7.0	....	....	.....
Babbitt 3.....	70.0	10.0	20.0	....	....	.....
Babbitt 4.....	80.5	11.5	7.5	0.5	....	.....
Babbitt 5.....	0.5	68.0	....	1.0	30.5	.....
Babbitt 6.....	....	20.0	....	....	80.0	.....
Babbitt 7.....	....	86.0	10.0	4.0	....	.....
White metal 1..	82.0	....	12.0	6.0	....	.....
White metal 2..	3.0	7.6	3.8	2.3	83.3	.....
White brass....	....	64.0	....	2.0	34.0	.....
Bronze 1.....	11.5	11.5	....	77.0	....	.....
Bronze 2.....	15.0	8.0	....	76.2	....	P = 0.80
Bronze 3.....	9.5	10.0	....	80.5	....	.....
Bronze 4.....	....	3.0	....	97.0	....	.....
Bronze 5.....	....	15.0	....	85.0	....	.....
Bronze 6.....	15.0	7.0	....	78.0	....	.....

Machinery

Note: P indicates phosphorus.

Cast-iron and Babbitt Spindle Bearings

Experience has shown that very satisfactory service is obtained from a hard steel journal running in a cast-iron bearing. With such a combination, it is found that the cast iron has a tendency to become glazed on the surface in such a way that the coefficient of friction between the bearing and its journal is very small, thus making the transmission efficiency of the bearing correspondingly high; also a bearing of this kind is so hard that wear becomes almost a negligible quantity. In Fig. 7 there is shown a type of spindle bearing construction which has been adopted as a standard by the R. K. LeBlond Machine Tool Co., of Cincinnati, Ohio, in building lathes, milling machines, and cutter grinders. This consists of a cast-iron box at the front end and a babbitted box at the rear end of the spindle, and the results obtained by this combination have proved so satisfactory in practice that a detailed description will be of interest.

The spindle is made of 50-point carbon steel, and over this there is pressed at the front end a hardened steel bushing made of Shelby seamless tubing. In making this bushing, the blank is cut off and annealed, after which it is bored, turned, and carburized; then it is necessary to round up the bushing to remove any distortion which has been produced during the heat-treatment, after which it is reheated and quenched in water to make it glass-hard. After hardening, the bushing must show a scleroscope hardness of 80 degrees, and those which fail to fulfill this test are heat-treated again. The hardened bushings are ground on the inside and rough-ground on the outside, after which they are again tested for hardness before being pressed onto the spindle. The fit of the bushing on the spindle is so adjusted that from seven to ten tons' hydraulic pressure is required to push it into place, after which the bushing is ground to standard size. The cast iron for the bearing is cast against a chill to make the metal dense and close-grained. Mention has already been made of the fact that this hardened steel journal is carried in a cast-iron bearing box which is an integral part of the main headstock casting. This eliminates an extra joint between the bronze box or a babbitt-lined bearing, and affords a more rigid construc-

TABLE 2. ALLOWANCE FOR OIL BETWEEN SHAFT AND JOURNAL IN MEDIUM AND HIGH-SPEED BEARINGS

Diameter of Journal	Allowance	Diameter of Journal	Allowance	Diameter of Journal	Allowance
⅜ to 1	0.002	3⅝ to 4½	0.005	6	0.009
1⅛ to 2½	0.003	5	0.006	7	0.011
2⅝ to 3½	0.004	5½	0.007	8	0.012

Machinery

tion, although the work of scraping the cast-iron spindle bearing to an accurate fit and perfect alignment is a difficult job, calling for the services of an experienced mechanic. A cast-iron bearing of this type must be more accurately finished than either a babbitted or a bronze-bushed bearing, because no dependence can be placed upon the spindle wearing itself to a satisfactory fit after the machine is placed in service; the bearing must fit properly before the machine is started. Several years ago the R. K. LeBlond Machine Tool Co. built four trial headstocks equipped with the following combinations of journals and bearings: (1) Cast-iron bearings and soft steel spindle; (2) bronze bearings and soft steel spindle; (3) babbitted bearings and soft steel spindle; and (4) cast-iron bearings and hardened steel spindle.

Lathes with spindles of these types were kept in constant use on work of the same general character, and when examined, the condition of the hardened steel journal running in a cast-iron box was found to be the best, neither the spindle nor the box being worn to an appreciable extent and the grinder and scraper marks still being visible. The combination of a soft steel journal and bronze box was in good condition, but the journal was slightly ridged in the center. The soft steel spindle in a cast-iron box was appreciably worn, but the soft steel spindle in a babbitt box was in first-class condition. There are lathes in the LeBlond shops at the present time in which hardened steel spindles have been running in cast-iron boxes for about twelve years without any adjustment having been necessary. The wear is so slight that it can scarcely be measured with the most delicate instruments. It is very important, however, to have the combination of a hardened steel spindle and cast-iron box, because a soft steel spindle and a cast-iron box is much less satisfactory than a soft steel spindle running in either a bronze-bushed or babbitted bearing.

At the rear end, the spindle of LeBlond lathes, milling machines, or cutter grinders is supported in a babbitted bearing. It will be seen that the seat for this babbitted bearing is

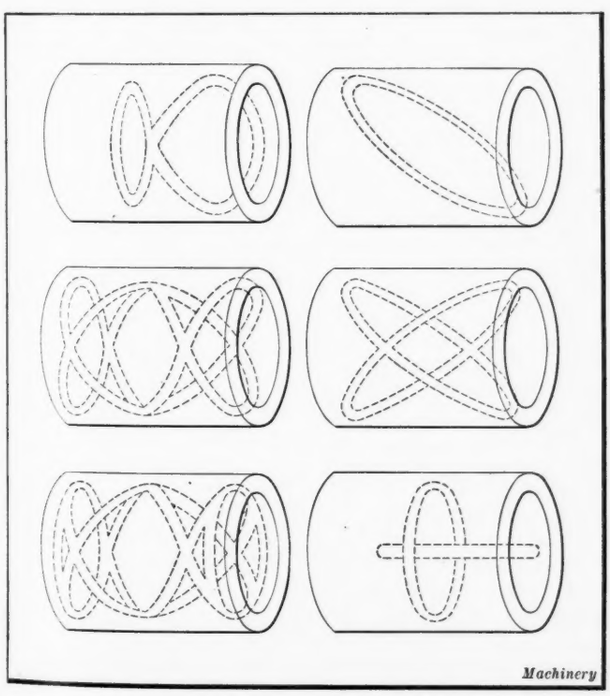

Fig. 11. Examples of Bronze Bearing Bushings showing Different Forms of Oil-grooves

dovetailed and the babbitt is poured, after which the bearing is bored in position. No attempt is made to peen the metal. Experience has shown that wear on the back bearing in a headstock of this construction is proportionate to the wear of the front box with its hardened steel journal running in a cast-iron bearing. Practically no attention is required by bearings of this form after the front bearing has run for a sufficient time to enable the cast iron to become glazed. The metal becomes so hard on the surface that it can scarcely be "touched" with a scraper.

Composition of Metal Alloys Used in Bearing Boxes

Various materials are used for lining plain bearings, among the more common of which are bronze, babbitt, and brass. The principal qualities required of a good bearing metal are that the coefficient of friction between the bearing surface and the steel journal shall be as low as possible, in order to provide for the efficient transmission of power and freedom from both wear and the tendency of the bearing to become heated while in service; also, the metal must possess sufficient compressive strength so that the bearing will not be distorted, due to pressure of the shaft, or broken when subjected to sudden shocks. Bronze is usually understood to be the name

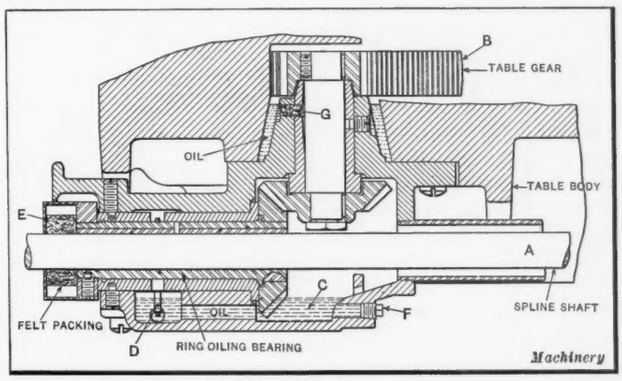

Fig. 12. Method of lubricating Table Gear Bracket of Vertical Surface Grinding Machine

given to an alloy of copper and tin as distinguished from brass, which is an alloy of copper and zinc. A bronze is usually understood to have more copper than tin, and the properties of the metal differ widely according to the percentages of these constituents which are present. In general, the alloy tends to harden when tin is present up to 30 per cent, but when this limit is exceeded, the alloy takes on more and more the nature of pure tin. Bronze mixtures commonly used for bearings contain from 3 to 15 per cent of tin and 85 to 97 per cent of copper. Bronze containing over 15 per cent of tin has been recommended in some cases, but, owing to its hardness, such a bearing must be of perfect form before it is placed in service and must be very carefully lubricated. Alloys of copper and tin were originally understood to be true bronzes, and today the term "bronze composition" is used quite commonly to designate alloys of copper, tin, and lead which are used for making bearing boxes. A bearing lined with bronze containing lead is less liable to heat under the same conditions of lubrication, and the rate of wear is also much less. A further advantage is found in the fact that lead is cheaper than tin, so that it is desirable, from a commercial viewpoint, to use an alloy containing as much lead as possible. One bearing bronze of this character contains 78 per cent of copper, 15 per cent of lead, and 7 per cent of tin. By adding from ½ to 1 per cent of nickel to the alloy, more lead may be used.

The commonly used babbitt metals consist of alloys of lead, antimony, copper, zinc, and tin in various proportions. Two or more of these constituents may be present. Alloys containing a high percentage of antimony are suitable for use in heavy-duty machinery, as they are harder, while alloys containing a low percentage of antimony are adapted for use in high-speed machinery. Soft babbitts have not sufficient strength to sustain the weight and shock of heavy-duty machinery bearings and can only be used as a liner; even so, the babbitt must be of the proper type, or trouble is likely to be experienced from distortion of the babbitt allowing the shaft to drop and the babbitt metal to be displaced to a position above the shaft, thus throwing machine members out of alignment. Frictional resistance becomes less in alloys containing higher percentages of antimony than is the case where this constituent is present in smaller quantities, and the temperature of the bearing is likewise diminished when running under normal conditions of speed, pressure, and lubrication. In Table 1 is given the composition of various alloys which are commonly used for bearing boxes, and in this connection it will be of interest to note the normal market price of vari-

ous metals which are constituents of these alloys. They are as follows: Lead, 4 cents per pound; zinc, 5 cents per pound; antimony, 9 cents per pound; copper, 15 cents per pound; and tin, 30 cents per pound. It will, of course, be apparent that these prices are far below those which exist in the present war-time markets.

Clearance between Journals and Bearing Boxes

In designing journals and the bearing boxes in which they are to run, care must be taken to so proportion the sizes of the journal and its box that just a sufficient amount of clearance will be left to provide the necessary space for a film of oil which is required in the bearing. This amount of clearance varies with the diameter of the shaft, and in Table 2 there is given the average amount of clearance which should be left for shafts of different sizes. In order to provide for uniform distribution of oil over the entire surface of a journal bearing, it is common practice to cut what are termed "oil-grooves" in the surface of either the journal or its box. These grooves are usually made in the form of a spiral or some kind of an endless curve, as shown in Fig. 11, which illustrates bearing boxes made by the Bunting Brass & Bronze Co., 748 Spencer St., Toledo, Ohio. Special machines are made for cutting oil-grooves, which provide for handling this work in a more expeditious manner than is possible with hand tools or on machine tools of standard design. There are several reasons for cutting oil-grooves in the form of spirals or other curved shapes, instead of adopting the practice of cutting straight grooves parallel to the axis of the journal. If such a practice were followed, there would be a tendency for oil to gather in the grooves near the bottom of the box, while those on the sides and top would remain empty. With oil-grooves of spiral or similar form, however, this trouble is not experienced and rotation of the journal has the further tendency of circulating the oil through these curved grooves, thus greatly facilitating distribution of the lubricant.

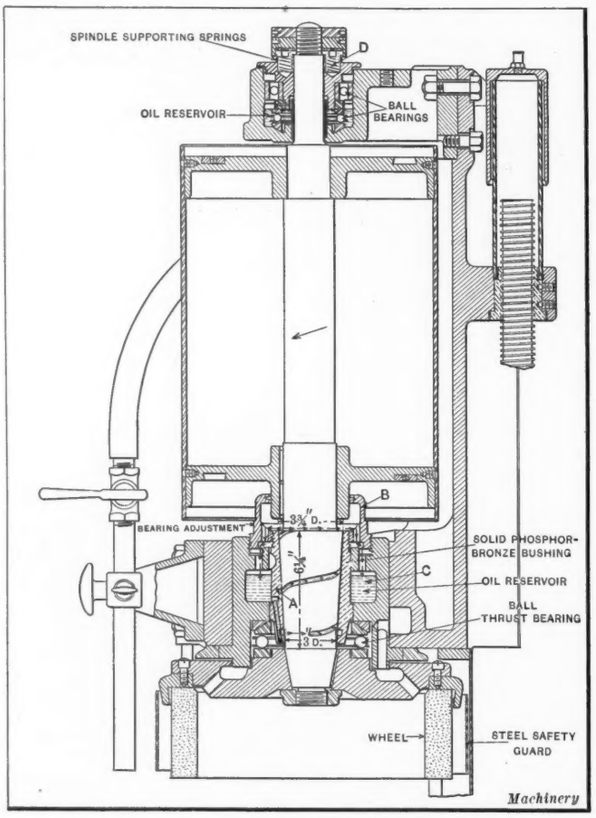

Fig. 13. Provision made for Lubrication of Spindle Bearings of Vertical Surface Grinding Machine

Lubrication of Plain Machine Tool Bearings

The ideal method of lubrication for the bearings in gearboxes on machine tools and other bearings, where such an arrangement is possible, is to have the gears run in a reservoir filled with oil. This not only avoids wear of the gear teeth, but it also provides for lubrication of the bearings by the well-known splash system of lubrication. Oil-holes are provided at the top of the bearings, so that oil thrown from the gears drops into these holes and provides a continuous flow of lubricant through the bearings. Where this arrangement is employed, an ample amount of lubricant can be put into the reservoir to last for several weeks, the length of time being governed by the conditions of service. A gage-glass is furnished on each reservoir, which shows the level of the oil, and at infrequent intervals it is merely necessary to replenish the supply of oil. When gears are running in mesh, or when a shaft is rotating in its bearing, the effect of friction is to tear off very fine fragments of metal which collect in the oil in such a reservoir; also, there is a tendency for a "muck" to collect in the bottom of the reservoir, due to oxidation of the oil. For these two reasons, and also owing to certain other causes, it is necessary to clean out the oil reservoirs at intervals of about six months. To facilitate this cleaning process, a drain plug should always be provided at the bottom of the reservoir which can be screwed out in order to drain off the dirty oil. The reservoir should then be flushed out with kerosene to clean away all accumulations of metal particles and oxidized oil, after which the drain plug is replaced and the reservoir refilled with clean oil. The same method of lubrication may be employed in the case of lubricant and oil-pumps, table traverse mechanisms, etc.

In the headstocks of "Filsmith" lathes built by the Philip Smith Mfg. Co., of Sidney, Ohio, all bearings are lubricated by the splash system with the exception of the main spindle bearings, which are oiled by sight-feed oil-cups. The reason for this is that it is felt that oil used in a geared headstock is bound to be contaminated with particles of metal abraded from the gear teeth and bearings, and that such impurities should not be allowed to enter the spindle bearings which are directly responsible for the accuracy of work produced on the lathe. This is, of course, a subject upon which there could be considerable discussion. In any case, where headstocks are lubricated by the splash system of oiling, all the oil should be drained from the head occasionally and the head should be thoroughly flushed with kerosene, benzine, or naphtha to clean all residue from the gears, bearings, and inside of the gearcase before a fresh supply of oil is added.

Lubrication of Bearings in Grinding Machines

An example of this method of lubrication is shown in Fig. 12, which illustrates the table gear bracket of the vertical surface grinding machine built by the Blanchard Machine Co., 64 State St., Cambridge, Mass. By building this mechanism as an independent unit, the process of manufacture is simplified, in addition to making provision for the efficient lubrication of the gears and bearings by application of the splash system of oiling. Referring to this illustration, it will be seen that the drive is transmitted through a spline shaft *A* and bevel gears to the table gear *B*. Oil is retained in reservoir *C* at the level indicated by shaded lines, and the bearing of the spline shaft is lubricated by the ring-oiling principle, which will be more fully discussed in connection with another example of bearing design. By this method, ring *D* runs over the bearing to be lubricated and its lower side dips into the oil carried in reservoir *C*. Rotation of the shaft results in continuously turning ring *D*, with the result that oil is carried up by the ring and deposited at the top of the bearing, thus delivering a constant supply of lubricant to the bearing. A felt packing *E* is employed to exclude abrasive dust, which would soon wear out the bearing if special precautions were not taken to prevent it from getting between the rubbing surfaces; and telescopic tubes form an effective seal at the right-hand end of the shaft. When it is required to clean out reservoir *C* by the method which has already been explained, drain plug *F* is withdrawn in order to provide for the escape of dirty oil from the reservoir and the flushing out of the reservoir with kerosene so as to remove all accumulated foreign matter before a fresh supply of lubricant is added.

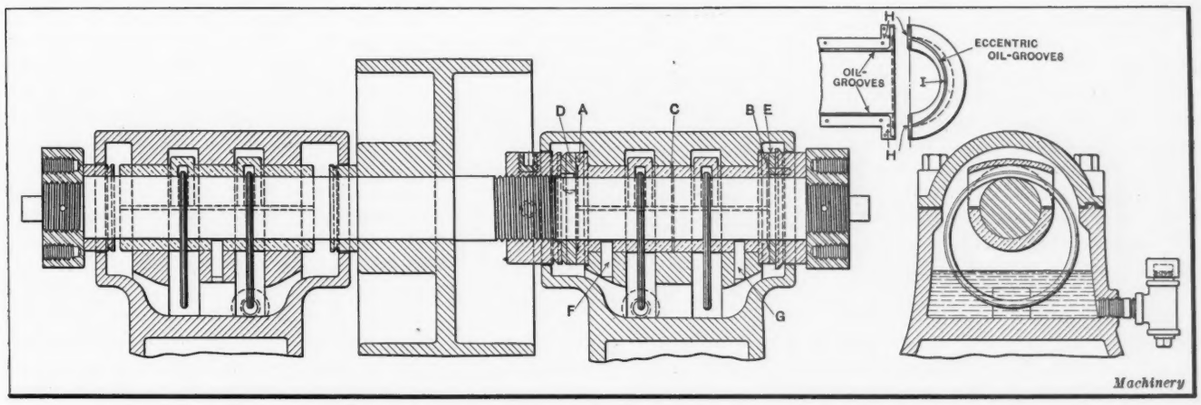

Fig. 14. Application of Ring-oiling Principle for lubricating Combination Radial and Thrust Bearings on Disk Grinding Machine

To provide for lubricating the bearing of the vertical shaft carrying gear *B*, oil is delivered through channels communicating with a felt packing *G* which is in contact with the bearing of the vertical shaft. This packing serves the double purpose of carrying a continuous supply of oil to the bearing and filtering out any foreign matter with which the oil may have become contaminated. Any excess oil which passes through this bearing is caught in the lower reservoir and replenishes the supply of oil for lubricating the gears and the ring-oiled bearing of the horizontal shaft. Felt packings are very generally used in this way to provide for delivering clean oil to bearings of grinding machines and similar equipments where the bearings are so situated that it is difficult to exclude abrasive dust and other substances that would rapidly score and wear out the bearings if they came in contact with the rubbing surfaces.

Provision for Lubricating Vertical Grinding Wheel Spindle Bearing

In Fig. 13 there is shown a cross-sectional view of the wheel-head of a Blanchard belt-driven vertical surface grinding machine; and the design of the bearings for carrying the wheel-spindle, together with the means provided for assuring efficient lubrication, will undoubtedly prove of interest. This entire wheel-head is carried on a vertical slide, so that alignment of the spindle bearings is made entirely independent of the slide. It will be apparent from the illustration that there are ball thrust bearings at both the lower and upper ends of this spindle; and for carrying the radial load there is a bronze bearing at the lower end of the spindle and a radial ball bearing at the upper end. The great advantage of ball bearings in such a case is that they may be packed with grease and housed in such a way that the grease is kept in the bearing and adequate protection is afforded against the entrance of grit and other foreign matter, which would abrade the bearings. With such an arrangement, the bearings require practically no attention, provided they are furnished with the proper kind of lubricant which is chemically neutral; that is to say, free from both acid and alkali. The mounting of these radial and thrust ball bearings conforms with a standard practice, of which a detailed description will be given in a later section of this article, but the reader's attention is called to the hemispherical seats on the races of the ball thrust bearings which fit corresponding surfaces machined to receive them. It is the purpose of this arrangement to have the hemispherical surface on the race adjust itself for slight inaccuracies in alignment or to compensate for slight strains which develop in the wheel-head, thus enabling the bearing to distribute the thrust load over all of the balls and assuring efficient transmission of power.

At the lower end of the spindle there is a tapered bearing which is arranged with the large end of the taper at the top, so that it is impossible to transmit any of the wheel thrust to this bearing. Tapered bronze bushing *A* can be easily raised by turning the threaded ring *B* to provide for taking up any wear which develops between the spindle bearing and its bronze box. This adjusting ring *B* is turned by a spanner wrench and the bronze bushing is not split. The provision of means for delivering lubricant to this tapered spindle bearing is particularly interesting. Lubricant is delivered to an oil reservoir *C*, from which it flows down through a channel cut in the bronze bushing at the left-hand side of the spindle to gain access to the spiral oil-groove which is cut in the journal. Oil is carried up through this groove, and in this way a liberal supply of lubricant is always distributed over the bearing. Upon reaching the top of the bearing, excess oil finds its way into channels at each side of the spindle and flows down through these channels into reservoir *C*, where it is available for subsequent use. By studying the direction of flow, which is indicated by arrows shown in this illustration, the reader will easily obtain a perfectly clear idea of the way in which oil circulates through this bearing.

The upper end of the spindle carries a threaded collar with springs *D* beneath, which press up against it with a force exceeding the weight of the revolving parts by at least five hundred pounds. By this means, the thrust bearing at the lower end, on which depends the accuracy of the grinding, is always kept tight. All backlash in the spindle is eliminated and variations of spindle length with temperature are automatically corrected. The downward reaction of the springs is carried on a ball thrust bearing in the upper box, and side pull at that point, due to the belt, is taken on a radial ball bearing.

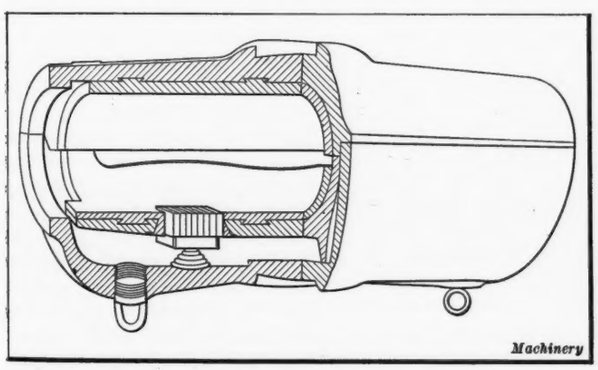

Fig. 15. Self-oiling Type of Bearing where Lubrication is effected by Capillary Action

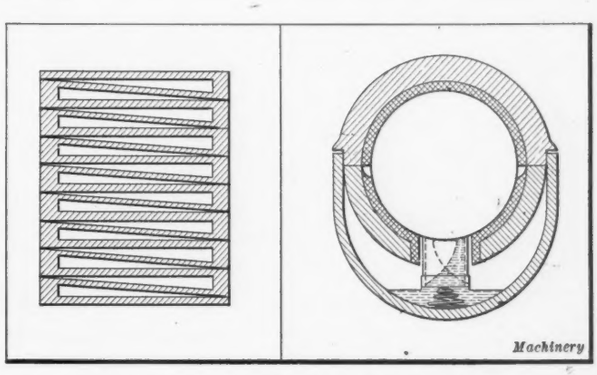

Fig. 16. Diagram illustrating Principle governing Operation of Capillary Bearing

Ring-oiling System of Bearing Lubrication

Another method of providing for automatically delivering oil to a bearing is to furnish one or more rings which are hung over the top of each journal and extend down sufficiently below the journal at the under side so that they dip into a reservoir filled with oil. As the journal rotates, it carries the rings around, thus bringing the portion of each ring which was formerly immersed in the oil up into contact with the top of the journal. The ring carries a considerable amount of oil with it, and in this way a constant supply of oil is deposited on the journal, which assures its efficient lubrication. A good example of the application of ring-oiled bearings in machine tool design is shown in Fig. 14, which illustrates the spindle construction of a disk grinder built by Charles H. Besly & Co., 120 B N. Clinton St., Chicago, Ill. The bearings are so constructed that they are dustproof, which is an important feature on the bearings of any grinding machine, and, in addition to the ring-oiled radial bearings, thrust bearings are provided to support the load which is applied in an endwise direction. This combination radial and double end thrust bearing is automatically oiled.

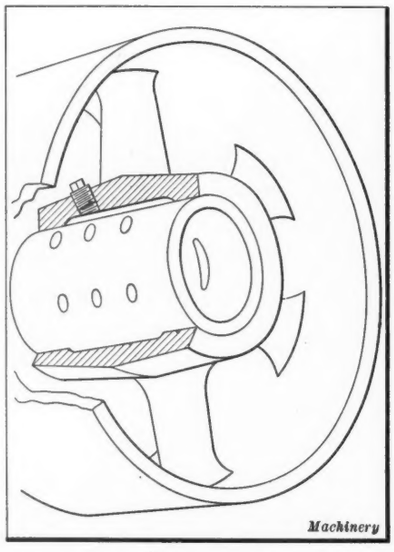

Fig. 17. Bronze Bushing provided with Means of automatically drawing Oil from Supply Reservoir

It is claimed that this ring-oiling device is so efficient in operation that the spindle literally floats on an oil film, thus greatly reducing the amount of power required to drive the machine. Tests which have been conducted to determine the transmission efficiency of these ring-oiling bearings are said to have shown that it is within 2 per cent of the efficiency of ball bearings. In the operation of ring-oiled bearings of this type, the oil should be drawn off about every six months, the exact length of time depending upon the conditions of service under which the bearings are operated. The oil wells have ample capacity; for instance, on the No. 17 Besly disk grinder, with a spindle 2½ inches in diameter, the oil wells are 7 inches deep. Two solid steel rings are provided for each bearing, which operate through channels cut in the bearing bushings in such a way that it is impossible for a ring to be displaced and fail to operate properly. The bearing boxes are split to facilitate assembly, and the housings in which these boxes are inserted are so arranged that replacement of the boxes is an easy matter when this becomes necessary. A special grade of phosphor-bronze is used for the boxes, and they are designed with ample bearing surface so that there is very little wear.

On disk grinding machines, considerable end thrust is set up when work is forced against the grinding wheel, and this is particularly true in the case of machines furnished with a lever feeding mechanism for the work-table. On single-spindle Besly disk grinding machines a grinding wheel is mounted at both ends of the spindle, which makes it necessary to design the bearings in such a way that provision is made for supporting the thrust load which is applied in both directions. It is also important to work out the design in such a way that there will be no end motion of the spindle while a grinding operation is being performed, because this would prevent the work from being ground accurately to size and would make it impossible to produce duplicate parts. End play is taken up by adjusting collars threaded onto the spindle under the flange of the driving pulley. The machine can be safely operated without any end play in the spindle. In Fig. 14 it will be seen that end thrust is supported by flanges *A* and *B* of the right-hand bearing bushing. Attention is called to the fact that this bushing is made in two parts, which are separated at *C* with sufficient clearance space, so that in the event of any longitudinal expansion of the bushing, due to a rise in temperature during operation of the bearing, such expansion is taken up in the clearance space without affecting the lateral adjustment of the spindle; also, there will be no tendency for the bushing to swell outward along the spindle and bind against the thrust collars *D* and *E*, which are located at opposite ends of the radial bearing bushing. Attention is called to the fact that the bushing is anchored in the head of the grinding machine by means of two pins *F* and *G*, which fit into holes that are slightly elongated to permit expansion or contraction of the bushing without causing any unnecessary strain. There are no holes through the caps which cover each of the bearings on this machine, so that it is impossible for grit or dirt to find its way into the bearings.

In working out this design, an interesting method has been provided for lubricating both the thrust and radial bearings. Referring first to the detail view of a part of the bushing which is shown separately, it will be seen that the liner *H* is set back in order to form an oil-groove along the radial bearing at both sides of the spindle. These oil-grooves extend to the end of the bushing and then in an outward direction almost to the periphery of the flanges on the radial bearing which engage the thrust collars. The thrust faces of both flanged ends of the right-hand bearing bushing are grooved, as shown at *I*, and carry oil to all parts of the thrust bearing. The groove is circular in form, but eccentric with the spindle, and it is made of such diameter that all portions of the face of each hardened thrust collar which bears against the flange on the radial bearing pass over the oil-groove during one revolution of the spindle, which insures oil reaching all parts of the thrust bearing. Oil is also delivered to this groove from the oil-grooves formed by the bushing liners *H*, to which reference has already been made. As the oil-grooves in the thrust bearings are circular in form, an eccentric with the spindle rotary motion of the thrust collars against the oil in the grooves tends to circulate this oil and provide a copious flow of lubricant. After this type of disk grinder spindle bearing was adopted, it was found practicable to increase the speed 75 per cent where such an increase was desirable.

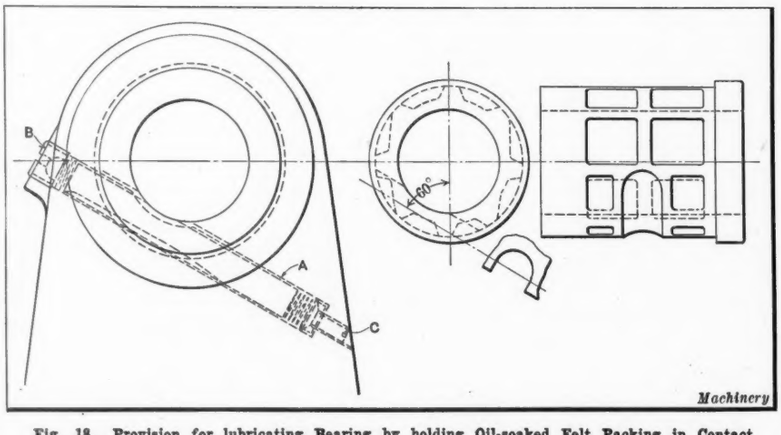

Fig. 18. Provision for lubricating Bearing by holding Oil-soaked Felt Packing in Contact with Bearing by Spring Pressure

Oiling Lineshaft Hanger Bearings

In shops where the equipment is quite congested, it is likely to be found that there is danger of accidents to men whose duty it is to oil the bearings of lineshaft hangers, countershafts, and similar equipment where the bearings are placed in somewhat inaccessible positions. A little time given to the subject of devising meth-

ods of lubrication may often be the means of saving serious accidents and consequent litigation over employer's liability. Observation of the following points will often result in saving trouble: Wherever possible, the work of oiling bearings in lineshaft hangers and countershafts should be done while the machinery is not running. A better plan is to equip such bearings with automatic lubricators which only need to be filled at infrequent intervals; with bearings of this type, it is always feasible to arrange to replenish the supply of lubricant at some time when the machines are at rest. It will always happen, however, that certain conditions will arise, making it necessary for shafting to require attention while the machines are running, and to meet such contingencies, safe means of access must be provided, among which mention is made of the following:

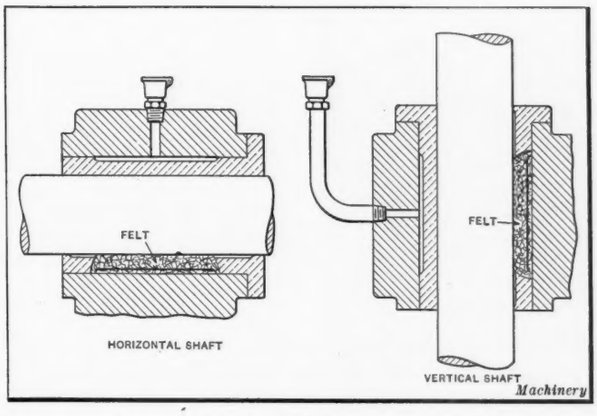

Fig. 19. Method of lubricating Horizontal and Vertical Machine Tool Driving Shafts

Where ladders are used to reach lineshafts and countershafts, they should be provided with hooks or hangers to fit over the shaft at the upper end and spurs at the lower end, which will insure obtaining a secure grip on the floor. With such provision, there is no likelihood of a ladder slipping and causing the workman to be thrown into moving parts of a machine. In big shops it will sometimes be found feasible to have a service platform or "runway" provided with guard rails and toe-boards running parallel to lineshafts, so that any point on the shaft is readily accessible. Moving parts of machinery should not be allowed to project over such a runway, but if such a condition is unavoidable, the moving part should be completely enclosed. In some plants, use is made of a car hung from an I-beam running parallel to the lineshaft, and with such an equipment the oiler can readily move along the shaft to reach all of the bearings. The use of such a car or of the service platform is naturally restricted to quite large shops. Some shops have their men use forced-feed oil-cans of sufficient length so that they can be operated from the floor.

Where men are employed to look after the work of inspecting and oiling shafting and other equipment before the regular starting time of the plant, accidents sometimes happen through the engineer's starting up the machinery before these men have finished their work. This source of danger can be overcome by providing disconnecting appliances which make it possible to cut out any section of the equipment until the work of oiling bearings has been completed. Switches used for this purpose should be provided with padlocks, so that they can be locked in either the open or closed position. If such appliances are not installed, it is good practice to require a man employed in oiling equipment to report personally to the engineer of the plant that he is going to oil certain machinery. Probably the best safeguard in the lubrication of bearings used in all inaccessible equipment is to adopt the use of one of the so-called "self-oiling" types of bearings which can be furnished with a supply of lubricant that is adequate for a considerable period of time. Bearings of this type are furnished with means of drawing oil from the reservoir and delivering it to the bearing surface, so that constant and efficient lubrication is assured. The features of various bearings of this type are described in the following paragraphs.

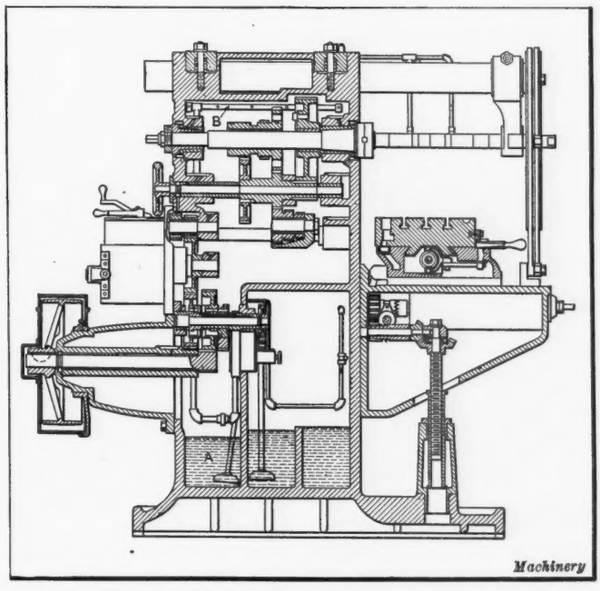

Fig. 20. Provision for delivering Continuous Stream of Oil to All Bearings and Gears in Milling Machine Drive

Types of Self-oiling Bearings

The so-called "self-oiling" type of bearings may work on either of two principles; oil may be taken from a reservoir and carried up to the bearing by any suitable means, or the bearing box which surrounds the journal may be impregnated with some form of lubricant. The latter type of bearing is often referred to as an "oilless bearing," although in many cases it is found desirable to give bearings of this type perhaps 25 per cent of the quantity of oil which would be required for the efficient operation of a bearing of standard design. The great advantage of self-oiling or oilless bearings is that they do not require as much attention as the ordinary type, and in the event of neglect to supply such bearings with the quantity of lubricant which they are expected to receive, they are capable of operating for a considerable length of time without serious damage.

Dodge Capillary Self-oiling Bearing

In Fig. 15 there is shown what is known as a capillary type of self-oiling bearing, which is suitable for use in lineshaft hangers and similar types of equipment. This bearing is made by the Dodge Mfg. Co., of Mishawaka, Ind. The bearing box has been designed with an opening at the bottom, in which there is inserted a wooden block that extends down through the box for a sufficient distance so that the lower side of the block can dip into an oil reservoir provided in the bearing housing. The block is held against the shaft by a spiral spring, and it has a series of slots sawed in it which come to a sharp angle at one end. It is the tendency of the oil to rise in the narrow end of these slots in the wooden block, as a result of capillary action, which is responsible for carrying oil up to the bearing.

Perhaps a better idea of the arrangement will be secured after referring to Fig. 16, which shows a cross-sectional view of the wooden block, illustrating the way in which it is slotted, and a cross-sectional view through the bearing showing how the oil is drawn up in the narrow side of these slots in the wooden block, due to the capillary action which has just been mentioned. A uniform film of oil is maintained on the shaft in this way, and oil-grooves are cut in the bearing box in order that these grooves may be kept full of oil, thus facilitating lubrication of the bearing. As there is no mechanical agitation of the oil contained in the reservoir in this bearing, any foreign matter which is present in the oil is allowed to settle to the bottom, so that only pure oil is admitted to the bearing and no trouble is experienced through grit or other foreign materials rapidly wearing the bearing surfaces. The reservoir in this bearing has sufficient capacity to contain a supply of oil

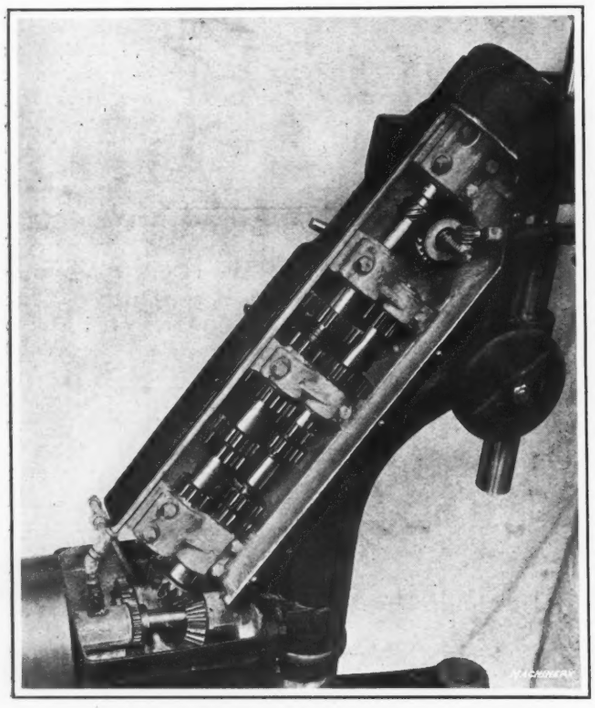

Fig. 21. Provision for Continuous Lubrication of Gears and Bearings on Vertical Drilling Machine

which is adequate to keep the bearing efficiently lubricated for a period of six months. Before replenishing the supply of oil, the bearing should be thoroughly cleaned, and this result is easily accomplished by removing the drain plug at the bottom of the reservoir and flushing the entire bearing with kerosene, after which the plug is replaced and a fresh supply of oil placed in the bearing.

Moccasin Bronze Bushing with Provision for Automatic Lubrication

Another type of self-oiling bearing is shown in Fig. 17, which is especially adapted for use in loose pulleys and similar installations where it is desirable to have the combination of a bronze bearing box and provision for automatic lubrication. This bearing is made by the Moccasin Bushing Co., of Chattanooga, Tenn. It will be seen in the illustration, which shows the method of mounting this bearing, that an oil reservoir is provided in the hub of the loose pulley, and the principle by which lubrication is effected is quite similar to that of the bearing furnished with a wick, through which oil is drawn by capillary action. Moccasin bushings can be used in any type of machine member furnished with an oil cavity from which lubricant can be drawn by the capillary oil-feeders which are contained in holes that pass transversely through the bushing so that they come into contact with the bearing surface in the manner shown on the inside of the bushing. They deliver a continuous supply of oil to the bearing, and are so prepared that they cannot glaze or clog. It is claimed that these bearings prevent the waste of oil, in addition to supplying the bearing with exactly the desired volume of oil which is required for its efficient operation.

Oilless Bearings

The Bound Brook Oilless Bearing Co., of Bound Brook, N. J., manufactures two types of the so-called "oilless" bearings. On the bearing surface, there are cast symmetrical grooves of various designs, depending upon the service for which the bushing is intended. These grooves are packed solid by means of hydraulic pressure with a special hard graphite lubricant. When the bushings are once installed and in use, fine particles of the graphite lubricant are distributed over the entire bearing surface of the bushing. Ample lubrication is provided for almost any form of bearing contact, whether the movement be oscillating, vertical, horizontal, or full revolution. Owing to the scientific design of the graphite grooves which fits them for the particular service required, wear is reduced to a minimum. The design of the graphite-packed grooves varies in different bushings because some bushings are subjected to different kinds of contact from others. These bushings are suitable for use in machine tools, countershafts, lineshaft hangers, electric motors, etc., but, although they are styled "oilless" bearings, it is recommended that about 25 per cent of the volume of oil which would be required to efficiently operate an ordinary plain bearing of the same size should be applied to these Bound Brook oilless bearings. However, in the event of failure on the part of the attendant to give the bearing the required oil, this lack of attention is not so likely to result disastrously, as would be the case with an ordinary bronze-bushed bearing.

The other type of oilless bearing made by the Bound Brook Oilless Bearing Co. consists of a bushing made of either hard maple or iron wood, which is thoroughly impregnated with a mixture of graphite and other lubricant by a special treatment. These are more truly "oilless" bearings than the type that has graphite inserts, because when the bearing is in operation a slight increase in temperature resulting from friction causes the bearing to exude some of the lubricant with which it has been impregnated, thus providing for efficient transmission of power. These bearings are especially adapted for use in loose pulleys; and in many cases they are run without any provision for lubrication. Some users prefer to drill the usual oil-hole in the hub of the pulley and in the bushing, so that a little oil can be added from a squirt can, and very satisfactory results were obtained where the bushings were used in this way. They must be properly supported to prevent splitting, although with sufficient support these wooden bushings have ample strength to resist any crushing load to which they will be subjected when used in loose pulleys and similar positions.

Another type of oilless bearing is made by the Graphite Metallizing Corporation of Yonkers, N. Y. In the manufacture of these bearings, graphite bushings are made of the required sizes, and these are impregnated with white metal or bronze to produce what is known as "graphalloy." In the March number of MACHINERY an article entitled "Manufacture of a Self-lubricating Bearing Material" was published, in which there was given a complete description of the process of manufacturing oilless bearings of this type. Speaking generally, these oilless bearings are adapted for use in light-duty machinery operating at high speed, and for heavier service where the speeds are comparatively low; their use is particularly to be recommended in cases where the application of oil is either objectionable, difficult, or likely to be neglected. In the machine shop, oilless bearings find application chiefly in loose pulleys and conveyor systems, and for supporting shafts which are mounted in a vertical position. As a general rule, the bearing pressure per square inch of projected area should not exceed fifty pounds. When placed in service, the surface of a graphalloy bearing soon becomes coated with graphite which is smooth and very hard.

The Aurora Tool Works, of Aurora, Ind., are using oilless bearings made by the Arguto Oilless Bearing Co., 145 Berkley St., Wayne Junction, Pa., to support the loose pulley on a new drilling machine they have recently placed upon the market, which was illustrated and described in the May number of MACHINERY. The use of this type of bearing was adopted because flooded and splash lubrication is used at other points on the machine, and the oilless bearing avoids danger of lubrication of the loose pulley bearing being neglected. This type of bearing has been found to give very satisfactory results for carrying the loose pulley on this drilling machine.

Lubricating Device for Machine Tool Bearings

There are many different methods in use for applying lubricants to the bearing of machine tools. In Fig. 18 there is shown one method worked out by the Garvin Machine Co. which has given very satisfactory results. Where this method is employed, the bearing box is cut away to receive a metal tube *A* which runs diagonally across the under side of the bearing box, the tube and bearing box being fitted together as indicated. This tube *A* carries a compression spring in its lower end, and at the upper end there is a threaded cap *B* which may be removed to provide for replenishing the supply of lubricant when desired. The tube is filled with felt, and

when oil is introduced into the upper end of the tube by removing cap *B*, this felt becomes thoroughly saturated. By means of the compression spring at the lower end of the tube, the felt wiper is always held in contact with the shaft by entering through the section of the bearing box which is cut away for that purpose, with the result that a supply of oil sufficient for the requirements of effective lubrication is continually being applied to the shaft, as it rotates in contact with the oil-soaked felt wiper. This method of lubrication has been found very efficient. At certain intervals, it is found necessary to clean out this tube and to provide for so doing there is a threaded plug *C* carried at the lower end of the tube. This plug is removed and the tube is then drained and flushed with kerosene, after which plug *C* is replaced and a further supply of lubricating oil is poured in at the upper end of the tube.

Method of Lubricating Bronze-bushed Shaft Bearing

In Fig. 19 there is shown a standard form of construction which has been adopted for bearings used to support horizontal and vertical driving shafts on machine tools built by the Morris Machine Tool Co., of Cincinnati, Ohio. Simplicity is the important feature of this construction. Oil is delivered through a tube which carries it into an annular space machined in the outside of the bronze bearing box, and the oil flows around through this space to the opposite side of the box from the point at which the delivery tube is connected. Here there is a slot cut through the box to communicate with the inside or bearing surface, this slot being filled with felt. The oil flows through the felt to the bearing, and the felt serves the double purpose of filtering impurities from the oil and acting as a wiper which distributes the oil evenly over the surface of the bearing which it is required to lubricate.

System of Automatic Flooded Lubrication on Machine Tools

When geared feed-boxes were first developed for use on "Milwaukee" milling machines built by the Kearney & Trecker Co., Milwaukee, Wis., an important step was made in advancing practice in the design of machine tools of this type. It soon became apparent, however, that in order to give efficient service, the gear-boxes would have to be provided with some means of continuous lubrication. After studying the merits of various methods, the design finally adopted consisted in constructing oil-tight boxes, so that the gears dipped into the oil. This result proved so satisfactory that attention was turned to the idea of adopting a geared spindle drive, but to accomplish this result the gears had to be placed one above the other, thus precluding the possibility of having all of the gears dip into an oil bath. Finally, provision was made for lubrication by having the gears placed one above the other and delivering oil to the top gear by means of a pump drawing its supply from a reservoir, as shown in Fig. 20 at *A*, and delivering the oil through holes in pipe *B*. While in operation, a gallon of oil per minute floods down over the gears and bearings. It will be apparent that at the top of each bearing there is a cup which catches part of the oil thrown by the gears and allows it to run down through a duct to the bearings. In this way, both the gears and bearings are kept thoroughly lubricated, so that efficient transmission of power is obtained and wear is reduced to practically the absolute minimum. In ordinary practice, the oil-grooves are closed at the ends to prevent the escape of oil from the bearings, but in the present case the grooves are cut right through to provide for a free circulation of oil and the washing away of all foreign substances from the bearings.

On 20-inch all-geared drilling machines built by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill., all bearings, with the exception of the spindle sleeve and cross-spindles, are continuously oiled by an automatic lubrication system. Oil is delivered by a geared pump in the reservoir of the machine and distributed constantly to all gears and bearings, including the crown gears and feed-box. This automatic lubrication system is manufactured under license from the Kearney & Trecker Co. A close view of the mechanism of one of the Barnes drilling machines is shown in Fig. 21, and the geared pump, which is driven by the constant-speed driving shaft, will be seen at the bottom of the oil reservoir. Oil is drawn into this pump through a strainer, which is also located at the bottom of the reservoir, although it is not shown in the illustration. There is a valve which can be set with just enough resistance to lift the required volume of oil to the crown gear bearings, while the remainder of the oil overflows directly into the oil-hole for the rear bearing. The pipe which will be seen just underneath the "backbone" of the machine, leading up to the crown gears, has small holes drilled in it just above each of the bearings in order that oil may escape to provide for the constant lubrication of bearings on both of the diagonal shafts. A groove is cut inside of each double bearing which leads the oil across to the lower diagonal shaft. A sufficient volume of oil is delivered to the crown gear housing so that the overflow runs into the feed-box, from which it works down through the worm-shaft bearing, and in so doing oils the worm and worm-wheel, after which it is led back into the frame of the machine and cascades back to the original reservoir. In this way, every bearing, aside from the spindle sleeve and cross-spindle bearings, is automatically supplied with a constant stream of oil.

* * *

TURRET ATTACHMENT FOR LATHE

In shops where it is occasionally necessary to handle a lathe job requiring the performance of a sequence of operations at a single setting of the work, but where there is not enough work of this kind to warrant the installation of a turret lathe, good results can be obtained with a turret attachment of the kind shown in the accompanying illustration. Here it will be seen that the turret is provided with five holes so that provision is made for handling work where any number of tools from one to five, inclusive, are necessary to perform the required machining operations. To index the turret, lever *A* is pushed down to release the locking pin; the turret is then turned by hand to bring the next tool into the operating position, after which the turret is locked in this position by turning lever *B* which actuates a clamp. The tool in the operating position is the only one in the group which revolves, and feeding of this tool to the work is accomplished by means of the handwheel which traverses the tailstock spindle. It will, of course, be apparent that the attachment is secured to the tailstock spindle by means of a bushing which is clamped over this spindle. This turret attachment, which is made by the Newman Mfg. Co. of Cincinnati, Ohio, provides means for converting an engine lathe into the equivalent of a turret lathe for handling those classes of work which come within its range.

E. K. H.

Lathe equipped with Turret Attachment made by Newman Mfg. Co.

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JULY, 1918

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

RAILWAY MACHINE TOOL REQUIREMENTS

The needs of our railways for machine tools during and after the war will be considerable; and if recognition of these needs takes the form of orders they will go far toward replacing the lessening demands of munition plants. It is stated that during the years immediately preceding the war the expenditure for machine tools and shop equipment for all the railroads in the United States averaged about $12,000,000 annually. During the last four years, however, that average probably dropped to about $7,000,000; and, because of the increase in prices for machine tools, we may estimate that only about one-third the number of machines was annually purchased during the war. The increased freight and passenger rates should insure a margin of net earnings which our railways have not enjoyed for many years, and the requirements of railroad shops for machine tools are likely to run into millions of dollars annually for a period of years.

* * *

SOME KNOTTY LABOR PROBLEMS

The small manufacturer is facing a difficult problem caused by the high wages paid both skilled and unskilled labor in the munition, shipbuilding, and other industries that have become abnormally active as a consequence of the war. The machine tool industry particularly has lost many good mechanics; because, although it has been prosperous during the past few years, manufacturers are unable to meet the competition of war industries which offer wages more than double those ordinarily paid in the machine tool trade. Another difficulty is the loss of time and decrease in efficiency caused by men "laying off" a day every now and then to look for other jobs with higher wages. One manufacturer says that recently his men averaged only 80 per cent of the full quota of working hours on account of taking time off to find better paying jobs. This, of course, reduced the efficiency of the entire plant 20 per cent; and as these conditions are prevalent in many parts of the country, a marked decrease in efficiency is noticeable. Owing to such circumstances, over which they have no control, manufacturers are unable to meet the delivery dates for war material at a time when there is urgent need for our maximum output.

It may be practicable for the Government to take some action to remedy this condition through the new board which is to regulate the relations between employers and labor. There should be some kind of central labor bureau, with the power to decide whether a worker should be permitted to pass from the employ of one concern to another. This would be a better method of handling the problem than the actual conscription of labor, which has been advocated in some quarters. In England one solution of the problem is presented by the Central Labor Bureau and the Volunteer Corps of Mechanics, whose members have agreed to perform mechanical work for the duration of the war wherever the Government needs them.

* * *

THE SALVAGING OF MACHINE TOOLS

Salvaging machinery and tools is a business well worthy of careful study both by users and makers; it promises to become, moreover, an important part of the machine tool industry. The salvaging of such tools as drills, reamers, and milling cutters involves, in general, principles easily understood by the average machinist, but when it comes to the salvaging or rebuilding of machine tools, he is confronted with a more complex proposition; one, in fact, that would make most good machinists pause. They are familiar, in the main, with methods of manufacture which, for the most part, involve the removal of metal in order to form a piece to the desired shape. Manufacture consists, roughly, in cutting away material where it is not needed; but to restore a worn machine tool to first-class condition, it is necessary to resort to various expedients out of the ordinary in machine tool manufacture.

Take, for instance, the case of a pair of worn gears; one, say, is a gear of 80 teeth, 4 diametral pitch, which engages a pinion of 16 teeth. These gears are found to be so badly worn that they must be renewed or restored to a condition as good as new. The large gear is rehobbed to a pitch circle corresponding to 79 teeth, thus producing a slightly thinner tooth than when new. A new pinion gear is hobbed with 17 teeth; and in this way the gearing is restored to a condition as good as new by recutting the large gear and renewing the small and comparatively inexpensive pinion.

The worn slides, especially the ways of lathes, must be replaned, scraped and fitted as if they were new. It is impossible to refit the worn ways by hand methods until the hardened shell formed by the sliding carriage has been removed with the planer tool. The lowering of the saddle requires readjusting of the apron so that engagement of the split nut and the splined feed-shaft will be right. In the case of planers, it is necessary to replane the ways and vees on the table and to cut out a corresponding amount from the rack seat in order to compensate for the metal removed from the ways and vees. Each machine is a study in itself; experience and good judgment are needed in order to obtain a satisfactory remanufactured product at a reasonable cost.

* * *

WEAK HANGER CONSTRUCTION

If safe working conditions are desired in factories, attention must be paid to the construction of shaft hangers, as they are often defective. In one shop recently visited, where a certain kind of hanger had been discontinued on account of its flimsiness, the manager mentioned that the boxes had been suspended between two half-inch screws projecting from two to three inches beyond their supports; in other words, the box had been virtually suspended in mid-air and held only by these small screws against the pull of a four-inch belt. Hangers are not conspicuous and, when once installed, the defects in their construction are not easily observed, which is all the more reason why factory inspectors should give close attention to hanger construction. Workers may easily lose their lives or be crippled as a result of the weakness of a supporting screw that might have been made fifty per cent stronger at an increased cost of not more than five cents. The safety-first campaign has eliminated most of the dangers in machine shops, yet many small details seem to have escaped attention. Weak hanger construction is one of these.

SPEED UP *for* VICTORY

THIS war will be won, not alone by men with bayonets, but by the concentrated efforts of all the men and women of the nation. In these pregnant words, Lieutenant André Morize, of the French Army, concluding his address before the American Society of Mechanical Engineers at the convention in Worcester, summarized in a single sentence the immensity of our task and the great essential to success in the world war for democracy. This telling declaration points the sure and only road to Victory.

We must not only win this war, we must win it soon; and we must avoid anything and everything likely to delay our plans or hamper the production of essential materials. Modern wars are won not merely by men in arms, but also by machinery and material; and the men who produce the machinery and material are as necessary to success as the brave fellows fighting in the trenches. This truth should be brought home to every mechanical man in America—that upon *his* work Victory depends.

Three factors must be coordinated in the drive for Victory: The Ordnance Department that plans the work, the Manufacturer who provides the organization and machinery, and the Toolmakers and Machinists of America upon whose skill and toil the production of war materials must finally depend. If one link in this great chain fails, the whole structure collapses. If we are to have all the rifles, machine guns, heavy artillery, airplanes, tanks, and ammunition required, these three—the Ordnance Department, the Manufacturer, and the Workman—must cooperate intelligently, unselfishly, faithfully.

The Ordnance Department must Speed up for Victory. Work must not be held up pending decisions on petty details by high officials in Washington, when any intelligent mechanic can give the correct answer. The trained judgment of the experienced manufacturer can be trusted in minor details, and his practical advice and cooperation should be enlisted. He wants to help. The constant changing of designs must cease. We must begin to produce, and must learn to let good enough alone. We must profit by the experience of our allies, and not aim at too great originality in our endeavors. The enemy will not wait until the Ordnance Department is ready; the Department must be ready for the enemy. If the reorganization of a department is necessary, speed up the reorganization! Let us lose no more time. We must Speed up for Victory!

The manufacturer must do his share in the speeding up. It may mean smaller profits, but this is no time to think of profits. Criticism of the Government and its policies should cease, except when constructive. Faultfinding—without suggestions that are constructive, practical, and based on knowledge of the facts—is worse than useless. Controversies, either with the Government or with labor, that involve nothing but personal prejudices or opinions, cannot be tolerated now. New methods of training men must be adopted, and the practice of taking trained men from other manufacturers who also work on materials necessary for Victory must cease. To win this war, we must cooperate, not compete.

The third link in the chain is labor. Every man at machine or work-bench must realize that *he* is a soldier in the great war; that *his* efforts are absolutely essential to Victory—to Democracy. The occasional day needlessly lost may mean a life lost at the front. Delay in the completion of a gage may mean delay in the making of a gun that would have held the desperate enemy at a salient in the fields of France. The toolmakers and machinists of America are, in the final analysis, the men who will win or lose this war. They should forget any grievances for the time being, for these weigh nothing in the balance that holds the fate of a nation.

Put in full time! Give the best that is in you! Remember that your work is as important as is the fighting of the boys in the trenches. Will you do your share as they do theirs? It is up to you. Speed up for Victory!

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HOW AMERICAN MECHANICS CAN WIN THE WAR

BY PRODUCING WAR MATERIALS, TOOLMAKERS AND MACHINISTS CAN DO AS MUCH AS MEN IN TRENCHES TOWARD WINNING THE WAR QUICKLY

BY B. M. W. HANSON[1]

WHAT is the most important thing that can be done to facilitate the production of war materials? To that question there is but one answer: Impress the toolmakers, machinists, and machine operators with the importance of the part that they play in the winning of the war; induce them to give their full time and maximum production; tell them to stick to their job, and not change from place to place, wasting the time that we cannot afford to waste; and make them understand that their interests are best served when they, in turn, faithfully serve the nation.

This is a war primarily of materials, not of men. The Allies, with Russia still fighting, were superior in man-power; yet, because of inferior materials, they could not overcome the enemy. Men cannot overcome materials; the partial successes of the last two German drives are proofs of this statement. Hence, to win the war we must create a superiority in materials; and to create this superiority the patriotism and loyalty of every mechanic in America must be aroused as it has never been before. Our men in France have already shown that they are going to do their part, and do it brilliantly. If the mechanics at home will do theirs equally well, there will be a superiority in war materials that will end the war in a fraction of the time that would otherwise be required.

This is No Time for Internal Strife

Labor is now earning higher wages than ever before. Hence, there is no reason for stirring up strife and discontent at this time. To do so at a moment when the country requires the faithful work of every man is to act the part of a traitor. Loyalty and cooperation are now the most necessary qualities required of American mechanics, if we are to be successful in quickly winning the war. Labor, in America, has an opportunity to do what in the past only armies could accomplish. Will labor do its part?

The unrest of labor has been due partly to a belief that the profits of the manufacturers of war materials have been unreasonably large and partly to an effort of men more unscrupulous than patriotic to take advantage of the situation to raise wages abnormally. In so doing, however, they have not held up merely the manufacturer—they have held up the nation itself. As to war profits, it is undoubtedly true that two or three years ago, before our own country was involved, there were many cases of huge profits; but as time has passed, the rising cost of materials, the higher level of wages, and the increased taxation have largely absorbed these profits, and today there are few manufacturers of actual war materials who are getting anything more than a normal and necessary return, and there are some who are not able to obtain even that. The Government is carefully scaling down prices, and this, in combination with rising costs of all kinds, has made excessive profits the exception rather than the rule.

Of course there are cases of profiteering, but these are less frequent in the direct production of war materials than in other lines of manufacture. In one instance, for example, a machine that is being built for $2000—labor, materials, and overhead included—is being sold for $7200. This machine has to be bought by the makers of war materials, so instead of profiteering, many of these manufacturers are themselves subjected to the unscrupulous actions of the profiteer. This sort of thing must stop. We want no more profiteering.

Labor's Opportunity

Labor, again, is paid better in the war manufacturing industries than in any other industry, and has generally shorter working hours. It is, therefore, to be hoped that our machinists and machine operators will realize their duty as Americans and will put into their work the full effort of which they are capable. We cannot afford to move leisurely if we are to win a victory over the still powerful enemy. American mechanics must rise to the occasion with determined loyalty and do their work as English and French mechanics are doing theirs. There are no strikes in France. There is no thought of jeopardizing the armies at the front by men and women at home refusing to work long hours. They know that there is but one way to hold back the enemy: "War materials! More war materials!"

It is to be expected that American mechanics will come forward voluntarily and do all in their power to cooperate with the men who offer their lives in France. The task of those that stay at home is easy. They receive better wages than ever for their work, and they have all the comforts that the American standard of living provides. All that their country asks of them is: "Stay on the job, and do your work to the best of your ability." Surely, American mechanics are not going to refuse to respond to that appeal.

Duty of the Trade and Technical Press

The engineering and technical journals of the United States can do no better service to the country, the industries, and themselves than by voicing this appeal. They reach tens of thousands of intelligent mechanics all over the country, and these men, when they fully understand the situation, will exert their influence on their fellow-workmen so as to counteract any influences that may be at work to destroy the loyalty of the great mechanical army of the nation. German propaganda is working over-time in our factories. It now clothes itself in the guise of the friend of labor, to instill in the minds of toolmakers and machinists the idea that they are exploited by the makers of munitions; when, as a matter of fact, the nation gives to the workers at this time a greater return than ever, and assures the conscientious mechanic opportunities that were never before within his reach.

To do One's Duty is Not a Sacrifice

The country asks for no sacrifice of the mechanic, as it does of the soldier. There is no sacrifice in working for reasonable hours at good wages or in investing in Liberty Bonds and War Savings Stamps on which a good interest is paid. The American workmen in the machine industries today are making absolutely no sacrifice. It is not a sacrifice to do one's duty. On the other hand, there are many manufacturers who, in order to increase production of war materials, are increasing their plants to such an enormous extent that it is inconceivable that they will ever be able to get full returns on their investment. Yet in the final analysis even these men are not making any sacrifice—they are only doing their duty. But, in addition to not making the sacrifices that are required of a great many other citizens, there is, for the machinist who thinks, and who realizes that he has a stake in the country, this remarkable advantage: He is called upon to serve as a skilled member of the one trade that more than any other will win the war; because to win or not to win is in the hands of the machinists of America. They have the greatest opportunity to prove the importance of their trade that has ever come to any trade or profession. When the war is over, the returning soldiers will tell how they would have been helpless in the face of the German armaments had it not been for the work of the machinists at home who provided the guns and the ammunition that ultimately crushed the enemy.

To combat German propaganda, to tell the mechanics of America that they should be careful of the influence of this secret force, to ask them to stay on the job and to grasp that opportunity that is theirs to go on record as being the most loyal and faithful mainstay of the armies in France, would appear to be the greatest service that journals like MACHINERY can render at this time.

[1]Vice-president and General Manager, Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.

MECHANICAL DATA IN CATALOGUES

VALUE IN DESIGNING FIXTURES

BY ALBERT A. DOWD[1]

Very few machine tool catalogues give sufficient information from the mechanical engineer's standpoint. The selling points of the machine and various features of interest or importance in the construction are carefully mentioned and illustrated, but this is done more to show the superiority of one particular type of machine over another than for any other reason. Yet is selling the machine the sole function of a catalogue? It does not seem to the writer that the sales department should dictate or specify the mechanical data to be contained in a catalogue. A machine tool is seldom sold directly on the strength of the talking points noted in a catalogue; usually a salesman must give some additional information before he can make a sale. When a machine tool is purchased, it is natural to assume that the mechanical features have been carefully considered by the chief engineer of the factory or by some other mechanical man familiar with the requirements; to this man the various mechanical features that pertain to the rapid handling of work are of supreme importance. In addition, the qualities of the machine and the way in which it is built will be considered with the greatest care.

Object of Mechanical Data in Catalogues

Suppose that it is desired to make a special tool equipment for a certain operation on work to be handled on a new machine and that the purchaser will not have the machine in his shop for some time. It is obvious that he will desire sufficient information about the machine to enable him to design the tools or fixtures to use with the machine, without having to write to the makers for it. The time required to obtain this information by writing for it, in many cases, will entail a serious delay, especially if the purchaser is in a foreign country. But if the catalogue were made up more carefully, from a mechanical engineer's point of view, a reference to it would give the purchaser all the mechanical data he would need. Within the last year, the writer had occasion to supervise the design of tools, jigs, fixtures, and gages for a foreign motor car, the machine tools for the manufacture of which were purchased in this country and shipped abroad. As the work was done in New York, it was frequently necessary to write to the various manufacturers of machine tools for the information needed to design the tools properly. In many cases there was a delay in obtaining the information and sometimes more than one letter was necessary. Nearly all the information requested would have been contained in the catalogues had they been properly prepared, and then it would have been easy to have designed the tools without taking up any matters with the manufacturers.

Important Information that is Not Given

In the case of a milling machine of the manufacturing type, one of the first things the tool designer needs to know is the width of the table and the dimensions of the T-slot in the table; a careful examination of a number of catalogues showed that nearly all the manufacturers give the width of the table, but very few give the dimensions of the T-slot. This is a small matter, but one that causes trouble in the design of tools. Also, in the case of vises and other tools used in connection with a milling machine, there are not sufficient dimensions given to enable a tool designer to design any part that will be used in connection with them. In the case of a set of vise jaws for a milling machine, the depth, width, length, and the distance between screw holes should be given in diagrammatic form. One catalogue contains a sectional view through a vise in which all the parts are distinctly shown; undoubtedly they are drawn to scale, as the drawing is a carefully made sectional line drawing, and yet not one dimension is given. While a table is given in connection with the illustration, this table gives no information of any importance to a mechanical engineer interested in the design of tools.

In drilling machines of the vertical type, the swing of the machine is frequently given in a misleading fashion. The overhang of the spindle from the column may be given as 9 inches, and yet, due to the offset of the ways from the column, it may not be possible to drill to the center of an 18-inch circle, although it would be assumed that such an operation could be performed.

Perhaps one of the most difficult machines on which to collect sufficient mechanical data is a turret lathe or chucking machine. On these machines there are a number of dimensions that are seldom given in the catalogue, and if any special tooling is to be applied, there is considerable difficulty in obtaining the necessary data unless the machine itself is accessible. If a faceplate of special form is to be applied to a turret lathe for holding a particular piece of work, it is necessary to know the dimensions at the end of the spindle so that the faceplate can be screwed into position; but the writer knows of no catalogue that gives this information. Also, if any special tools are to be applied to the cross-slide, it will be found that there is not sufficient information to allow a drawing to be made and at the same time be sure that the special tool-block will be properly supported. Besides, it is necessary to know the dimensions of special tools and the method of fastening them to the turret face. The amount of clearance over the turret-slide from the center of the turret hole should be given, so that if a tool is designed with a low-hanging part it can be positively decided whether or not this will swing clear as the turret is indexed. In addition, the dimensions between the ways of the machine and the distance from the center of the spindle to the ways should be shown. As a matter of fact, a view looking toward the headstock, showing the various parts in outline, with a few general dimensions, will be of the greatest value in many cases.

Need of Data Concerning Special Tools

In addition to this lack of data, special tools designed for turning various diameters, recessing, boring, and the like are frequently specified in the catalogues, but usually no dimensions are given, so that it is difficult for a tool designer to determine just what work he can do with them without going out into the shop and setting up the machine. If all tools of a special nature were shown as line drawings, properly dimensioned, it would be a great advantage to the tool designer.

At least one well-known manufacturer of machine tools in this country has come to an appreciation of this matter and is seriously considering the preparation of a catalogue based on the facts needed by a mechanical engineer in making up tool equipment for the machine. He believes that there is nothing to conceal in the mechanism of his machine and that the dissemination of a little more information about the construction will not do him any harm. If the machine tool builder will consider his machine from the viewpoint of the mechanical engineer in search of information, he will readily see what information his catalogue lacks. The average machine tool must be considered in conjunction with its tool equipment, and unless this equipment can be properly arranged to produce the work to the best advantage, the machine tool itself is a failure. Therefore, it behooves every manufacturer to give this matter the most serious consideration. If necessary, he should find from his tool department exactly what information it has access to when designing special tool equipment for the machine. It is natural to assume that any information this department may have is complete.

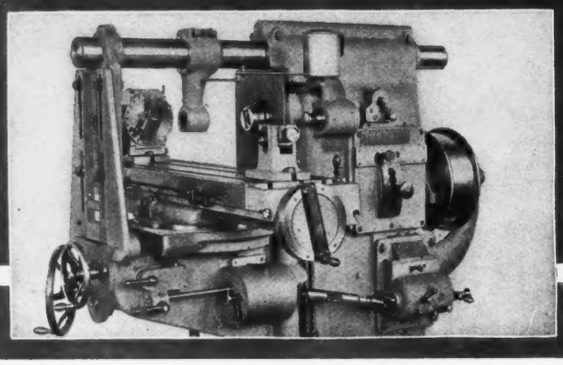
* * *

The National War Labor Board has announced its plans for the settlement of local industrial disputes that might interfere with war work. These plans provide for the appointment of local arbitration committees in industrial cities and subcommittees of the board to act in disputes that local committees fail to settle. The War Labor Board will hear cases only when the subcommittees of the local committees fail or on appeal from their decisions. Appeals will be heard in the following cases: Where the principles established by the President's proclamation have been violated; where an award made by a board has not been put into effect, or where employes have refused to accept or abide by the award; and where there are questions of jurisdiction, as between government boards.

[1]Address: 25 Church St., New York City.

Supports for Milling Machine Arbors

Historical Review Showing Early Designs



Development of Types Now Used

By Luther D. Burlingame[1]

ONE hundred years ago, when Eli Whitney made what was perhaps the first milling machine, it was elementary in character and naturally did not have any means for supporting the outer end of the arbor. About twenty years later, however, as the art of milling developed and became a well-established shop operation, one of the early improvements was to provide such means, first by the use of an overhanging arm combining the center head in the same casting, later by the use of an outer support without an overhanging arm, and finally by the combination of the two. These supports have taken many forms to adapt them to the needs of convenience, stiffness, ease of manufacture, etc., and have expressed the individuality of many designers.

The first known application of an outer support for the arbor of a milling machine had its origin in that pioneer shop in North Chelmsford, Mass., where Gay and Silver evolved so many of the features which have since proved fundamental in the development of machine tools. A Gay and Silver machine having an outer support (Fig. 1) was probably built as early as 1835, and the records show that machines of this design were regularly sold as early as 1841. This machine, which might be classed as of the "manufacturing type," had the overhanging arm cast as a part of the spindle head, and apparently a center carried by this arm was used to support the outer end of the arbor.

"Manufacturing machines" suggesting the Lincoln type of miller, which have since become so well known, were in use as early as Eli Whitney's time, but apparently none of the early designs had any provision for supporting the arbor. The first one found having this feature is accredited to Frederick W. Howe, the support being designed by him while he was with the Robbins & Lawrence Co., of Windsor, Vt., about 1850. This support is shown in Fig. 2 and illustrates not only the first known application of a support to the Lincoln type of milling machine, but also the first application of an outer support carried by the bed of the machine instead of by an overhanging arm.

The cylindrical overhanging arm next appeared, and it also seems to have been first applied to the Lincoln type of machine, this being the Root machine, designed about 1854 at Colt's Armory, Hartford, Conn. In this case the arm appears to have been attached to the face of the spindle head rather than extending through it, as in later designs of this type of machine, such as that since made by the Kempsmith Mfg. Co. A center was provided for the outer end of the arbor.

In 1857, Mr. Howe, already referred to in connection with the design of an arbor support, brought out a design of milling machine, while with the Newark Machine Co., which he called a "universal milling machine" and which showed the first application found of an intermediate support carried by an overhanging arm. Fig. 3 shows the arm used by Mr. Howe in this machine. It is of novel design, being a double arm, with each section made rectangular in form. The center head for supporting the end of the arbor was clamped in the space between the two arms and carried a center. The intermediate support engaged the end of the spindle, which, on account of the design of the machine, projected some distance from its front bearing.

Perhaps the earliest use of a cylindrical arm made solid with the spindle head is found in the unusual design brought out by Bement & Dougherty, of Philadelphia, shown by a drawing dated 1861, which is now in the possession of the Brown & Sharpe Mfg. Co. The rights were secured and the manufacture of these machines was undertaken by the latter company in what was for many years well known as their No. 13 plain milling machine. (See Fig. 5.)

Professor John E. Sweet proved a pioneer in many lines of mechanical development and put his impress on milling machine design in 1864 by bringing out a machine at the works of the Sweet & Barnes Co., at Syracuse, N. Y., which seems to be the first of the knee type of machine to have an outer support for the cutter-arbor. Professor Sweet showed himself to be well ahead of the times by his appreciation of the need of a rigid support. He made his support reach from the baseplate to the level of the spindle, with means for clamping to the knee and apparently with an outer bearing instead of merely a center to support the arbor. If this is the case, it is perhaps the first use of such an outer bearing. In a letter from Professor Sweet to the writer in 1914, enclosing a photograph of this machine, he said that he was keeping the machine for some museum, and it is to be hoped that if it has not already found a suitable resting place where it will be preserved, it soon may, as its historic value as a step in the development of the art of milling will increase as time goes on. It would seem that

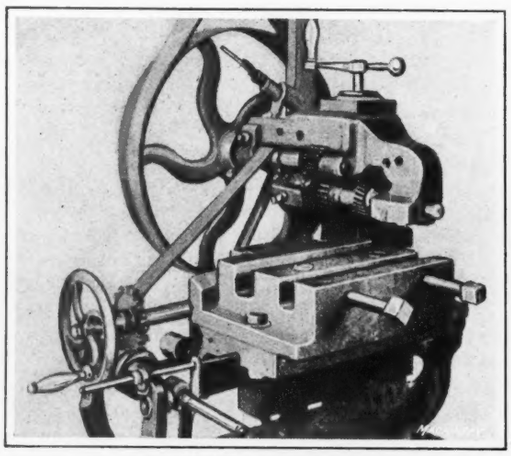


Fig. 1. Gay & Silver Milling Machine having Overhanging Arm or Arbor Support which is Integral with Spindle Head

[1] Industrial Superintendent, Brown & Sharpe Mfg. Co., Providence, R. I.

Cornell University, the scene of some of Professor Sweet's effective work when in his prime, would be the ideal place for this machine to be preserved. Since the time when the Sweet design was brought out, the feature of supporting the knee and arbor from the base of the machine in cases where special rigidity is required has been used not only in American but also in European practice.

During all these years no example is found of the combination of a brace for the overhanging arm as well as for the cutter-arbor. The earliest application of this kind seems to have been made by the Brown & Sharpe Mfg. Co. in 1873, in order to adapt its No. 1 universal milling machine for use in gear-cutting. This is shown in Fig. 4. A steel bar was bolted to the top of the frame, and this bar was provided with a square thread to allow for adjustment of the arm brace by means of nuts engaging the threads. It also had a keyway at the top to receive the points of two set-screws for clamping in place—a practice which has since been followed for the purpose of holding the center head in alignment, a modification being to provide a flattened spot on the cylindrical arm.

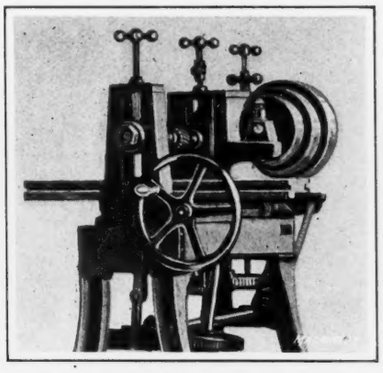


Fig. 2. Howe Milling Machine, designed about 1850, equipped with Arbor Support

cal were brought out. Those with angular ways were most common, examples being found on machines made in America, France, and England. A typical one, made by William Muir & Co., of Manchester, England, is shown in Fig. 7, and one of Bariquand & Marre, Paris, France, in Fig. 8. The combination boring and milling machine shown in Fig. 9 was patented by Albert D. Pentz, of Elizabeth, N. J., in 1889, and has flat ways on the overhanging arm and a rack and pinion adjustment for the center head. None of the overhanging arms of either type had been made adjustable in the frames of the machines prior to 1883, and the next step in advance was to make them adjustable so that they could be readily pushed back out of the way or removed. Lawrence Cosgrove, of Baltimore, Md., was the pioneer in this improvement, and machines having solid steel arms, as shown in Fig. 10, were first manufactured by Pedrick & Ayer under the Cosgrove patent. At about the same time, Charles E. Lipe, of Syracuse, N. Y., brought out a novel type of milling machine, which also had an arm sliding in the head. Both the Cosgrove and Lipe patents were purchased by the Brown & Sharpe Mfg. Co., and this and some of the

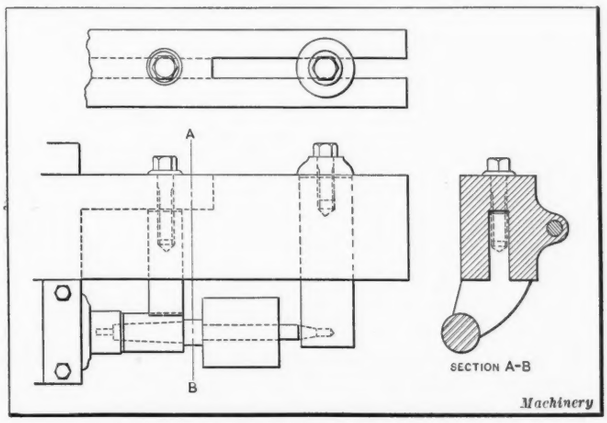


Fig. 3. First Application of Intermediate Support carried by Overhanging Arm; designed by F. W. Howe in 1857

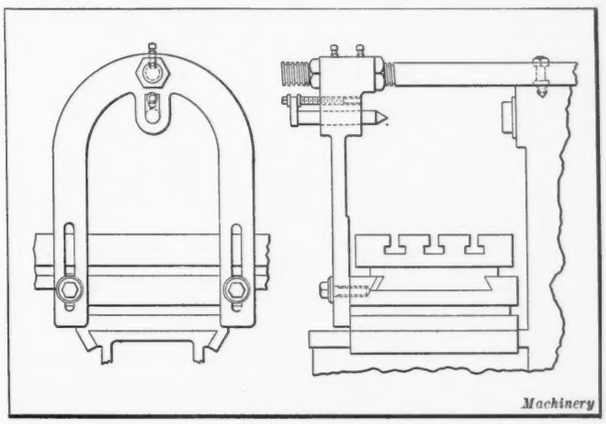


Fig. 4. Combination Brace for Overhanging Arm and Cutter-arbor; designed by Brown & Sharpe Mfg. Co. in 1873

The first regular application of an overhanging arm to a universal milling machine was in 1876, when the large size machine of that type was brought out by the Brown & Sharpe Mfg. Co., having a cast-iron arm as shown in Fig. 6. Up to this time the development in the style of overhanging arms seems to have been along two well-defined lines, one including the use of cylindrical arms, and the other the use of arms with flat or angular ways. In both designs the arms were either made solid with the frame or spindle head, as the case might be, or were bolted in place.

While the double rectangular arms of the Howe design (Fig. 3) were not repeated, many forms of arms other than cylindrical

other features of these patents were adopted in its regular line of machines.

The invention of the double arm brace (Fig. 11) by Charles H. Phillips, of the Brown & Sharpe Mfg. Co., in 1892, added materially to the progress in devising methods of rigidly supporting the outer end of the arbor. This was an important improvement, because at that time there began to be a growing demand for milling machines capable of taking heavy cuts. In the "Wanderer" milling machine, which is of German manufacture, is a combination of the Phillips double arm brace and Professor Sweet's idea of supporting the knee and arbor from the base of the machine. Such a support from the base

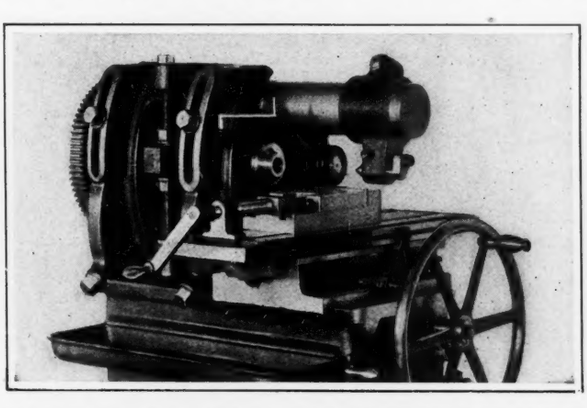


Fig. 5. Brown & Sharpe Machine provided with Cylindrical Arm which is Solid with Spindle Head

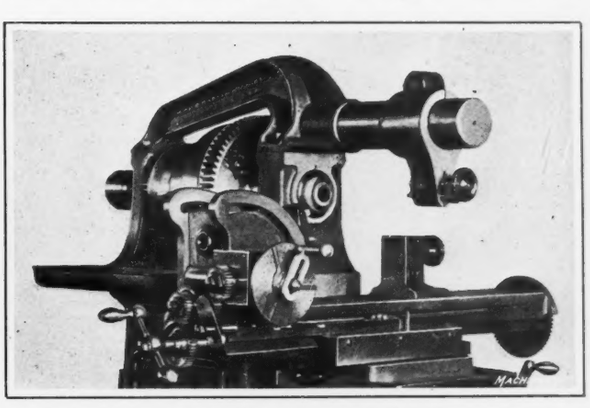


Fig. 6. First Regular Application of Overhanging Arm on Universal Milling Machine

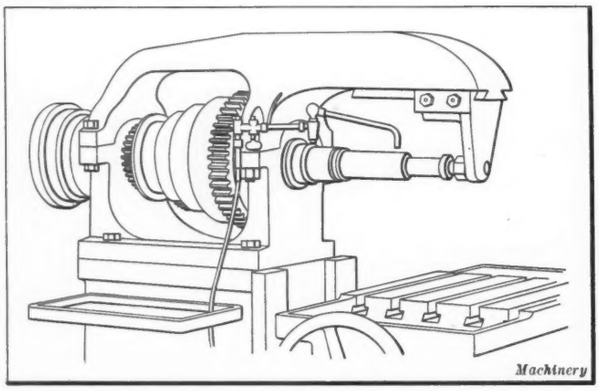


Fig. 7. Overhanging Arm having Angular Ways for Arbor Support

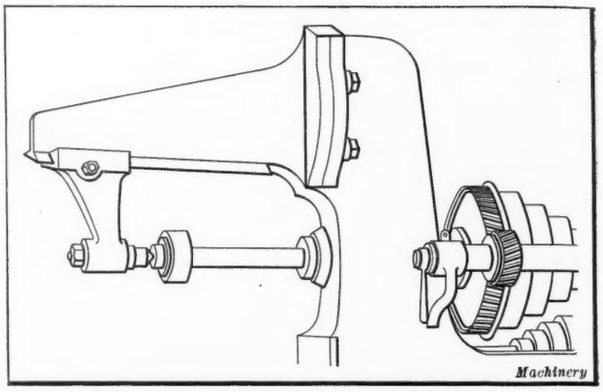


Fig. 8. Removable Overhanging Arm provided with Angular Ways

was also applied to the Muir machine of English manufacture (Fig. 12); the overhanging arm of this machine has angular ways for the arbor support.

Steps for increasing the rigidity of the arbor support in "manufacturing milling machines" showed a development along independent lines. Attention has already been drawn to the double outer support of the Howe machine (Fig. 2). At a later date tie-rods were added, fastened in the head and having a sliding fit in holes in the outer support, with means for clamping after adjustment. Such a construction is shown in an old Cox & Prentice catalogue prior to 1881, and has also been used by Pratt & Whitney in some designs of their

was also claimed that this arm provided improved means for attaining and maintaining accuracy of alignment. Still other methods of obtaining rigidity were originated at about the same time that the Norton machine was designed. Pratt & Whitney brought out a double-spindle milling machine with double arms tied together at the outer end, as shown in Fig. 14. This same feature was applied to a duplex milling machine having two work-carrying heads, built by the Brown & Sharpe Mfg. Co. a little later, in which the center heads for the work-spindles were carried by separate arms tied together by a single arm brace (Fig. 18).

At least as early as 1904 a French manufacturer (A. Vautier

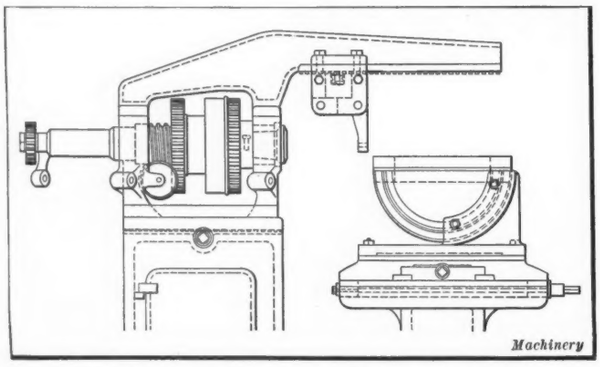


Fig. 9. Combination Boring and Milling Machine equipped with Overhanging Arm having Flat Ways

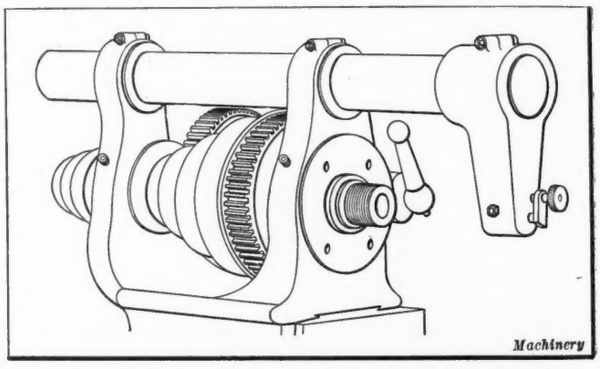


Fig. 10. Pedrick & Ayer Universal Milling Machine provided with Adjustable Overhanging Arm

Lincoln millers. A further development of this type of double support is shown in the Reinecker machine of 1900, which has two bars or arms sliding in the frame and in the outer support, so that they can be adjusted to any position or readily removed, as desired.

Mention has already been made of some of the steps taken to hold the cylindrical overhanging arm and its center head more rigidly in position by means of keys, flattened spots, etc. One method of securing this end was devised by Charles H. Norton, in 1892, when with the Leland, Faulconer & Norton Co., of Detroit, Mich. The arm was of square cross-section (see Fig. 13), and one of its "diagonal diameters" coincided with a plane intersecting the axis of the cutter-spindle. It

& Co., of Maubeuge) brought out a combined vertical and horizontal spindle milling machine, with double overhanging arms carrying an outer support for the cutter-arbor, as shown in Fig. 15, the double arms being evidently used for the purpose of supporting the arbor rigidly without an arm brace and in order to avoid interference with the vertical spindle of the machine. Further developments along the lines of using double overhanging arms were made by the Kearney & Trecker Co., of Milwaukee, Wis., and Potter & Johnston Co., of Pawtucket, R. I., in 1913. The Kearney & Trecker over-arm construction consists of two arms arranged so that both fit the arbor supports. The two arms are of the same size and are located some little distance apart, with the axes in a horizontal

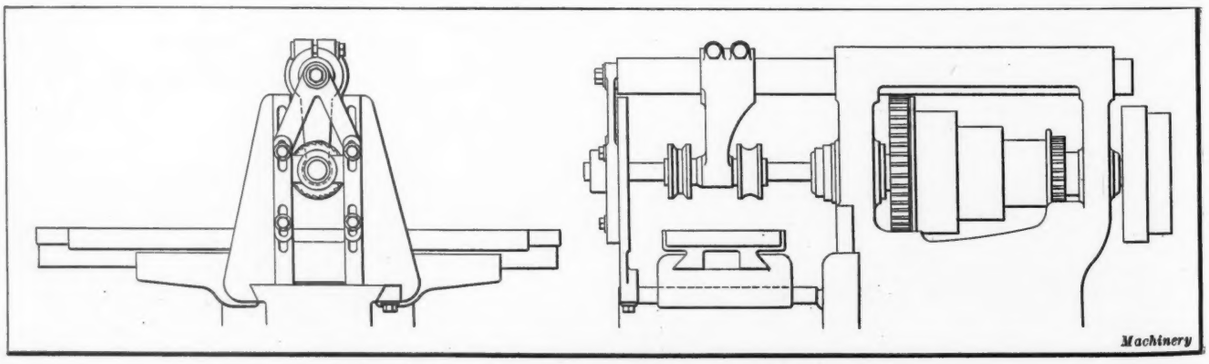


Fig. 11. Double Arm Brace applied to Brown & Sharpe Milling Machine in 1892

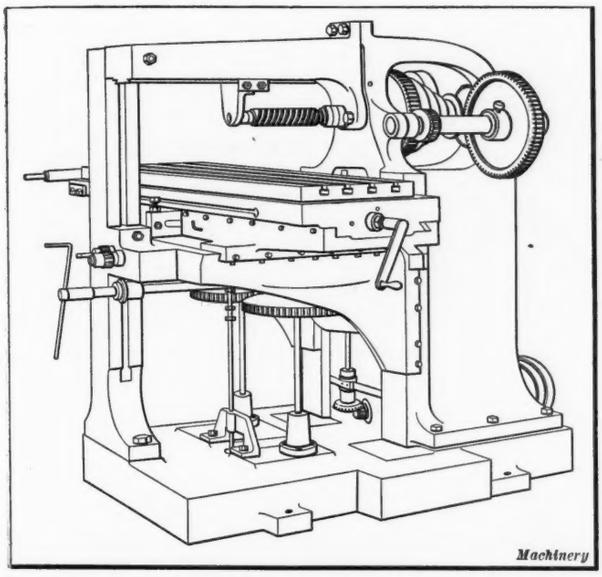


Fig. 12. Milling Machine of English Manufacture having Support for Overhanging Arm and Knee

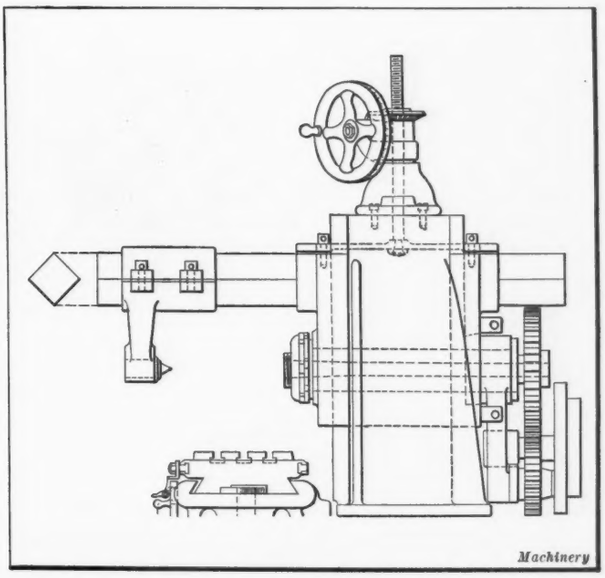


Fig. 13. Overhanging Arm of Square Cross-section designed to provide Rigid Support and Accuracy of Alignment

plane, so that the connections between the arms and the arbor form the outline of a triangle. The Potter & Johnston Co.'s machine had one arm located vertically above the other (Fig. 16), the idea being to so tie the two arms together that no arm brace would be required, as the method of operating the machine makes the use of an arm brace impracticable.

While the cylindrical arm appears to have been made adjustable in the head or frame of milling machines at an earlier date than the arms having angular ways, the provision for such adjustment in arms of the latter design soon followed. In the earlier designs of both types where there was no adjustment, the arms were often bolted in place so that they could be removed if the work was such that they would be in the way. (See Figs. 7, 8, and 9.)

The earliest application of an adjustable angular arm so far found in a milling machine was in a duplex machine made by the Brown & Sharpe Mfg. Co.; this arm was applied to the machine in 1894. It provides widely separated ways to give rigidity to the structure and carries an intermediate support having a fine adjustment by means of a set-screw.

In milling machines of the planer type the natural evolution has been to secure rigid supports not only at the end of the arbor, but at intermediate points as well, by attaching such supports to the cross-rail—a construction which also has the advantage of having widely separated ways.

An early use of an adjustable overhanging arm with guideways is found in the Mergenthaler machine brought out in 1899 (Fig. 17). In this case the arm is adjusted in the head

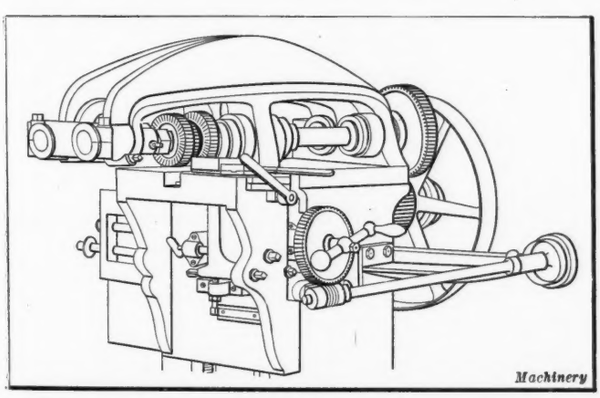


Fig. 14. Double-spindle Milling Machine having Double Arms tied together at Outer End, as designed by the Pratt & Whitney Co.

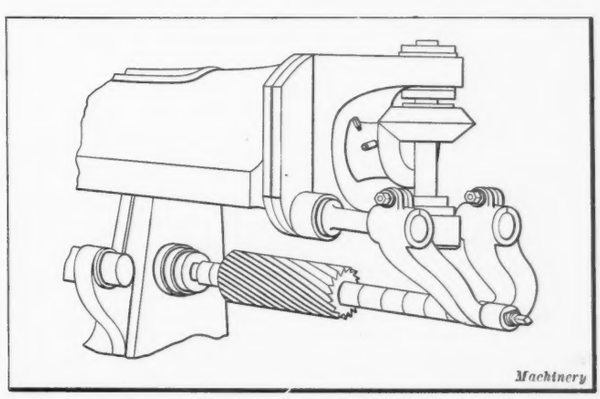


Fig. 15. Combined Vertical and Horizontal Spindle Machine of French Manufacture with Double Overhanging Arms

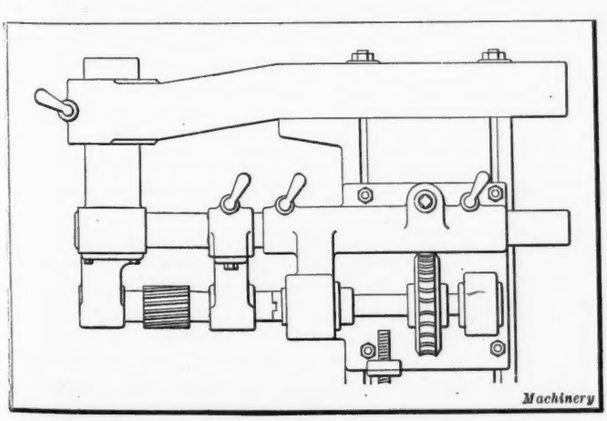


Fig. 16. Double Overhanging Arms located one above the other

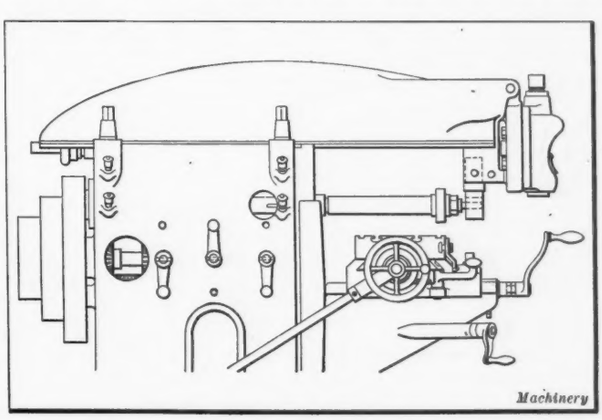


Fig. 17. Adjustable Overhanging Arm mounted in Guideway

by means of a worm engaging a rack. A still more complete disclosure of an adjustable overhanging arm with angular ways, having an adjustable center head and double-arm brace, is shown in the Sowden patent of July 28, 1903 (Fig. 19).

In manufacturing milling machines, illustrated by the Lincoln type, the tendency, in order to secure greater rigidity, seems to be toward the use of a heavy outer support with stiffening arms acting more in the nature of tie-rods to bind the structure together for stiffness. In the case of the knee type of milling machine, this tendency lies along two lines: one, the use of a rigid overhanging arm of steel with heavy arm braces tying it to the knee, or even to the base; the other, the use of double cylindrical or widened angular arms of sufficient rigidity to support the arbor by depending principally upon the strength and stiffness of the overhanging arms, the arm brace being comparatively light or entirely absent, and, when used, serving primarily as a brace rather than as the main support.

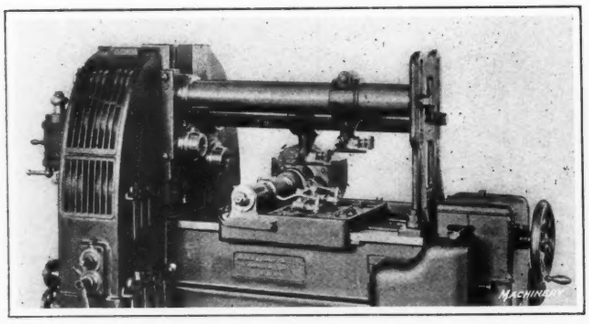


Fig. 18. Duplex Milling Machine having Separate Arms tied together by a Brace connecting with Machine Bed

The steps of development here outlined give another illustration of the gradual step-by-step evolution in mechanical design through many years from the first crude beginnings to a state of the art suited to modern needs.

* * *

NEW METHOD OF SOLVING TORSION PROBLEMS

BY MARK MEREDITH[1]

The determination of the distribution of stresses in members subjected to torsion has occupied many mathematicians and physicists. Without a knowledge of how such stresses are distributed, it is impossible to determine the local weaknesses of members of irregular section when under torsion, and therefore to modify the contour so as to secure the greatest strength within the limits of contour modifications laid down by the kind of duty the member is required to perform. Certain simple sections, like the circle, ellipse, rectangle, and equilateral triangle, for example, yield more or less readily to mathematical analysis, and a torsional-stress-distribution diagram of these sections can be constructed. But in the more irregular sections, the mathematical process becomes too complex and the designer of mechanisms comprising parts of irregular section subjected to torsional stresses has had to work in the dark.

The aircraft propeller blade is subjected to a particularly complex combination of stresses, among which is the torsional stress set up by the greater air pressure on the following than on the leading part of the curved face of the blade. The shape and dimensions of the blade section at any point are determined, within limits, by the requirements of stream-line and propulsive efficiency contour, and by resistance to bending, but there is a certain latitude within which modifications can be made to secure the maximum resistance to torsion. It is of extreme importance that the design should take cognizance of this factor, not so much because risk of fracture is thereby diminished as because, unless the distribution of the torsional stresses is known, it is impossible to forecast how the blade will deform in use, and consequently impossible so to shape the blade in its unstressed condition that it will present the desired features when under working stress. About a year ago the design department of the British royal aircraft factory at South Farnborough tried to determine the torsional stresses by working on the theory that the equations for the torsion of an elastic bar are of exactly the same form as those for the displacement, under evenly distributed pressure, of an elastic membrane, the shape of which corresponds to the cross-section of the bar. The calibrating instrument devised consists of a thin metal plate out of which a section corresponding to the cross-section of the blade is cut, and a thin membrane stretched across the opening. A slight excess air pressure is provided on one side of the film, and finally a means of registering the contour of the surface of the bulged film is employed. The first requirement was easily satisfied. For the second, a soap film stretched across the opening was used. The pressure on one side of the soap film was produced by clamping the plate over a box within which the air pressure could be delicately adjusted. The reflection in the film of a suitably placed single electric lamp filament shows the inclination of the film to the plane of the plate at any given point for the determination of stresses, and a steel needle pointing down toward the film, and adjustable as to depth by a micrometer, traces the contour lines of the film and records them by pin-pricks on a sheet of paper. By cutting in the plate, beside the slot of the section it is desired to investigate, a circular hole of the same cross-sectional area, it is possible not only to ascertain the distribution of stresses in the irregular member, but to determine, by comparison with the known stresses in the circular bar represented by the round hole, their actual value.

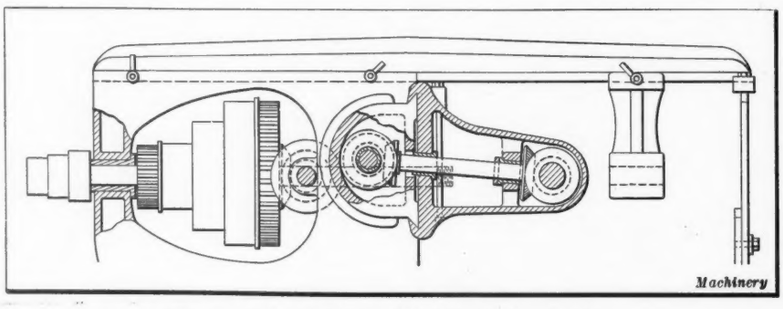


Fig. 19. Another Design of Adjustable Overhanging Arm

[1]Address: 67 Dale St., Liverpool, England.

* * *

MACHINISTS AND TOOLMAKERS FOR ARSENAL WORK

The Watervliet Arsenal, Watervliet, N. Y., is making the guns that will pound into the German mind the fact that there is such a thing as an undying belief in the ideal of justice in this world; and the arsenal needs skilled men in the making of these guns. Large additions are being built to the arsenal and these must be manned. A great number of toolmakers and machinists are needed for this work. Every mechanic, therefore, who is engaged on any work which is not necessary for the winning of the war should be willing to do his share by going to work for the Government. All the workers are directly under the Federal Civil Service and the Federal Compensation Law, and the wages are good. A special housing bureau devotes its entire time to getting homes for the new workmen, and no effort is spared to make them feel at home. Applicants, however, should not come to the arsenal without first writing to the Commanding Officer, Watervliet Arsenal, Watervliet, N. Y. No men who are now engaged in work for the Government or in the building of machines that are to be used for work on government contracts will be hired, but, with this exception, any American between the ages of eighteen and fifty-four who feels that he really wants to do his share in the great crisis through which the world is passing may apply for work at the arsenal and feel that he is doing his duty toward his country.

BLUING STEEL

MATERIALS, ARRANGEMENTS, AND METHODS USED ON LIGHT SHEET-STEEL WORK

BY W. B. GREENLEAF [1]

FOR bluing steel by the saltpeter process, the outfit necessary consists of a cast-iron kettle for melting the saltpeter mixture and tanks for the water and oil. The melting kettle may be heated by gas or oil; with kerosene oil at nine cents a gallon and gas at ninety cents a thousand cubic feet, the gas is about 60 per cent more expensive but is less trouble. The water tank should be connected to a steam or gas supply so that the water may be kept boiling hot; it should also

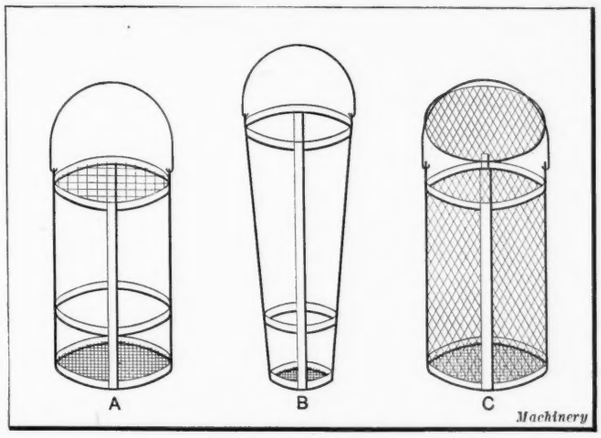


Fig. 1. Baskets for holding Work when bluing

have a fresh-water connection. Both the oil and the water tank should have waste cocks at the bottom. The writer uses a fifty-gallon round galvanized tank for the water and a thirty-gallon rectangular tank for the oil. Considerable heat is necessary for melting the mixture, but after it is melted the flame must be turned down to 20 or 30 per cent of full size, or the solution will get too hot and eat through the kettle.

The saltpeter mixture consists of nine parts, by weight, of saltpeter and one of black oxide of manganese, or pyrolusite, melted together. Either nitrate of soda or nitrate of potash may be used; but only the best quality should be used, for the cheaper grades are adulterated with common salt which interferes with the work. The writer has found "Aqualine" the cheapest satisfactory oil, but the Standard Oil Co.'s flat wire oil is good, and a mixture containing one part of lard oil and two or three parts of paraffine oil is all right. Paraffine oil by itself is not satisfactory, as it evaporates and leaves a coating of saltpeter on the work.

The work the writer has handled is stamped from sheet steel and is used for cap pistols and air rifles; heavier material may require a little different treatment to that described here. Cup-shaped articles must be hung on hooks or placed in racks so that they will drain; all other work is handled best in baskets. Large pieces should have special baskets to suit the individual shapes. All baskets should hang at least 1½ inch from the sides and 5 or 6 inches from the bottom of the kettle; Fig. 1 shows the types in daily use. Small parts may be thrown in loose, the only limitation being that the mass of metal must not be so great that the heat will not reach those in the center before the outside is too hot. In other words, where the parts are of such shape that they will pack closely together, the basket must be filled only two or three inches deep; curved or hollow shapes of thin metal, which pack so as to allow the solution to circulate rapidly all around them, may fill baskets as large as the kettle will take. Baskets for light material must have tight covers that are hinged and fastened; otherwise the parts will be thrown out when they are dipped into the water. Large or small pieces with curved surfaces may be packed close together, but large, flat, smooth surfaces must be kept a slight distance apart. A convenient basket for handling such parts is shown at *A*, Fig. 1.

[1]Address: Care of Kohler Die & Specialty Co., De Kalb, Ill.

All baskets should be made as light as possible. There are firms who will make better wire baskets than could be made in a shop; but if a homemade one is desired, it will be found better to use 1/2- by 1/16-inch strips, with electric welded joints, for the frames. For small pieces, the frames, sides, and bottom of the basket should be lined with 1/4-inch mesh galvanized wire netting, fastened in place by lacing with stovepipe wire, as shown at *C*. For larger pieces, the netting on the sides is unnecessary but an extra hoop should be placed a quarter of the way from the bottom, as shown at *B*. For the bottom of some of these baskets, 1/4- by 3/32-inch strips may be used, but 1/2-inch mesh netting is most commonly used. The covers for small work may be formed of 1/4-inch mesh netting, wired to a hoop made of a 1/2- by 1/16-inch strip. Each basket should have a handle.

A scraper should be provided for the melting kettle. A convenient form is made of 1/2-inch rod about 3 feet long, with a loop at one end and an oval-shaped piece of heavy sheet iron, about 3 by 5 inches, securely riveted to the other. This scraper is used to stir the solution and to scrape the sediment from the bottom of the kettle.

Convenient Arrangement of Outfit

The proper arrangement of the outfit is, of course, essential to quick and easy handling of the work. A satisfactory layout is shown in Fig. 2, where the kettle and the two tanks are set in a quarter-circle close together. The outlet cocks and steam and water pipes are placed close against the outer edges of the tanks. A lever, about eight feet long, is hung at the center of the tank circle by a swivel yoke and chain from the ceiling. The chain is guyed by wires just above the joint, to keep it from swaying. This lever is free to tip up and down and to swing in a circle. It may be made from one-inch pipe, but should have a short piece of chain at one end and a

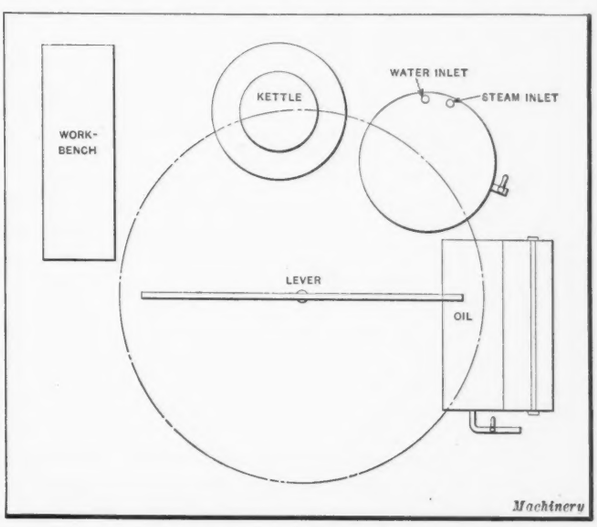


Fig. 2. Convenient Arrangement of Tanks for Bluing Process

longer piece at the other. The shorter piece should be passed through the ring of a large swivel harness snap and looped up to an S hook for adjustment; the longer piece should have a handle or ring at the end. To fasten the chains, the ends of the lever should be threaded for caps, each of which is drilled to take a link of the chain, which is held by a pin fitting tight inside the cap. The oil tank should be provided with a drip flange at the back and should have a row of hooks suspended from a bar above it.

The floor under and around the outfit should be of cement and pitched to a large drain just back of the tanks; the walls should be of brick, cement, or tile. The work gives off much flame, smoke, and steam, unless the roof is high and ventilated

like a foundry; the kettle and water tank should have heavy sheet-iron hoods with a direct outlet, not less than 20 inches in diameter, and forced draft if possible.

A low bench should be placed opposite the tanks at the other end of the lever, or to one side, for filling the baskets, and should have space enough to hold material for at least one day's work. There should also be hooks or nails on the bench, or special uprights opposite the kettle and the oil tank, to support the lever while the work is bluing and while the baskets are being changed. One man can handle this work with this outfit, as the articles have to stay in the solution long enough to load and unload the baskets. A helper does not increase the speed more than 10 or 15 per cent.

Method of Performing Work

To start the work, the kettle should be heaping full of the saltpeter mixture and the heat turned on full. As the mixture melts, more should be added so that when it is all melted, the solution is within two or three inches of the top of the kettle. The kettle should be kept covered until the material is entirely melted, especially after the first melting, for the hot solution spurts through the crust, and melted saltpeter burns badly.

A pailful of saltpeter and the black oxide should be mixed in the proper proportions, and between each heat a handful should be stirred in until it melts. In this way the level of the solution in the kettle will be kept uniform and the mixture will work much better than if the kettle is allowed to get low and is filled once in a while. The solution should be stirred from the bottom each time, during which operation the workman should wear canvas gloves. After the first time the mixture is melted, each time the kettle is started, before stirring, some of the sediment at the very bottom should be scraped out.

When all the mixture is melted, the solution clears up on top and begins to boil. It should then be tested by throwing on a pinch of fine dry sawdust; if this floats around and burns slowly the mixture is not ready; when the sawdust bursts into flame the moment it reaches the surface, the bluing process can be started.

The most essential and only difficult point in the process is maintaining the right heat. The writer has not used a pyrometer, which would undoubtedly be a great help. A test, which he has found entirely reliable, is the formation of scum by the burning oil on the surface; this should be entirely burned off at about the second minute. If there is scum on the surface at the end of the third minute, the work should be left in the mixture for fifteen seconds after the scum has disappeared and the heat increased; if the scum is gone by the end of the first minute, the heat should be reduced. Maintaining the proper temperature is vitally important to the production of good work. If the heat is a very little too low, the color is good though a little light, but it has dark spots, like the brown with purple spots in the tempering scale of steel. On the other hand, if the solution gets too hot, the work comes out very dark and mottled with dark streaks and spots. In the first stages of overheat, the effect is quite similar to underheat, but the whole tone is much darker; however the formation of scum has been found to be a sure temperature test. It is possible, by watching when the scum disappears from heat to heat, and adjusting the fire a very little at a time, to obtain a correct temperature. The writer has held it on the spot for three or four hours at a time without further regulating. However, the bad effects from both underheating and overheating can be entirely removed by running the material through again at the right temperature.

There is another serious danger from overheating. At the same point that the work shows bad, the kettle begins to turn red. As the chemicals attack the cast iron at red heat, they will eat into the kettle as long as it stays red, and will eat through the iron in a short time. As can easily be imagined, boiling saltpeter is not pleasant to have flowing around on the floor, and it is very hard to dig out of the furnace and pipes after it cools. If the kettle begins to show the least red, the only safe way, is to turn out the fire and light it again when the heat is reduced to the proper point.

In operation, the full basket is hung on the snap at one end of the lever and lowered into the solution by means of the chain at the other end. This chain is hooked so that the articles will be about two inches below the surface. As the articles are usually covered with oil and the baskets always are, this oil catches fire and flames, burning and smoking until it is all burned off. There is always more or less spattering of the solution so that the operator should keep the full length of the lever away from the kettle. The writer dips the work without cleaning off the grease from the presses and buff wheels; work that has been thoroughly cleaned with gasoline does not seem to be any better. There must be no rust on the work, however. For the work done in the writer's plant, three minute's is the proper time for the articles to remain in the solution; they will color in less time than that but the additional time gives a better tone and a stronger and more lasting coat. The time can be kept with an ordinary watch, but a stop-watch is much handier.

When the time is up, the basket should be slowly lifted from the solution and held over the kettle until the surplus solution drains off. Baskets of small pieces should be shaken. Then the basket should be dipped into the hot-water tank as quickly as possible without sloping over, as the steam helps to clean off the solution. The basket should be shaken enough in the water to clean the work thoroughly. The articles should be examined carefully as the baskets are emptied; if there is any solution (black mud) clinging to them the washing is at fault. After the surplus water is drained off, the work is dipped into the oil and taken out again as quickly as possible. The operator, of course, handles the basket all this time by means of the lever. The chain at the operator's end of the lever is then fastened so that the basket hangs over the oil while he adds his saltpeter mixture and stirs the solution in the melting kettle. He then hangs the finished basket on the rack to drain, puts on a fresh basket, and starts over. While the lot is bluing, he takes from the rack a basket that has drained, empties and refills it, and places it near the oil tank; he will have time left to watch his time and heat. At least four baskets should be kept going at once; one in the kettle, one being filled, and two draining.

There is time while the kettle is heating in the morning, which requires one or two hours, to move the previous day's work into the next department and to get a fresh supply. Of course the work of heating the water should be started at the same time as the kettle is started. The water tank should be drained and cleaned out every two or three days. The water and soft soap that settle under the oil should also be drawn off every morning and fresh oil added; and the sediment should be scooped out of the bottom of the oil tank.

* * *

CARBURIZE AND CARBONIZE

The two words "carburize" and "carbonize" are frequently used interchangeably in mechanical literature to designate the process of impregnating the surface of steel with carbon in order to raise the carbon content of low-carbon steel so that it may be hardened by heating to the hardening temperature and quenching in oil, brine, or water. "Carburize," however, is the correct term to use, and while the other term has been so generally employed that it has become recognized by dictionaries as an allowable word, its use should be discouraged. Webster's New International Dictionary defines carburize as "to combine or impregnate with carbon; as, to carburize iron by cementation." The word "carbonize," again, is defined as "to convert into a residue of carbon by the action of fire or some corrosive agent; to char." As a secondary definition, it is given as equivalent to "carburize." The proper meaning of carbonize, however, refers to the converting of a substance into carbon, as, for example, when a carbon lamp filament is carbonized, when the fiber from which it is made is charred. The Century Dictionary, therefore, defines a carbonizing furnace as a "gas furnace used for carbonizing the filaments of electric lamps," or as "an apparatus for carbonizing wood, disintegrating rocks, etc." A furnace used for increasing the carbon content on the surface of steel is not a carbonizing furnace, but a carburizing furnace.

FACTORY MOVING

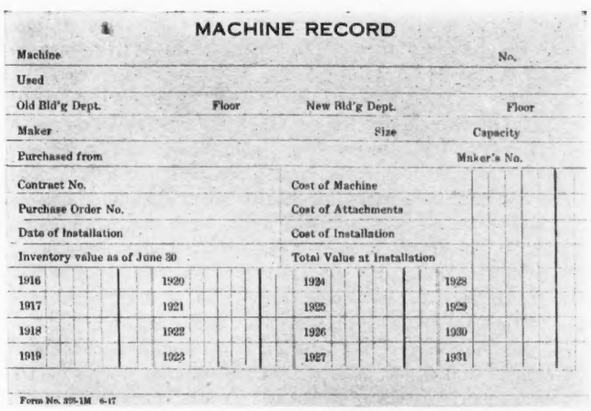
METHODS OF EFFICIENTLY SOLVING THE PROBLEMS ARISING WHEN MOVING MACHINERY INTO A NEW FACTORY

BY L. J. HENGESBACH[1]

THE ordinary person regards the moving of a factory as about the same thing as the moving of household effects; but, as a matter of fact, it is a very different proposition. The moving of any factory has several drawbacks, the most important of which is the interruption of work, with the resulting loss of business due to failure to make promised deliveries. Another bad effect is the disruption of the organization.

The labor involved depends on the extent of the move. If a factory is to be moved by rail from one town to another, it is necessary to crate and pack all the machinery, which involves the taking apart of many of the larger machines. All dies, tools, fixtures, etc., must also be carefully packed and the boxes marked so that the tools or other equipment for any machine may be readily found when the machines are being set up again. This is the most difficult kind of move to engineer. The easiest is that caused by the remodeling of a plant, when the machinery does not leave the factory, so that there is no chance of losing parts in transit. Between these classes is the moving of a factory to another location in the same town.

The size of the plant and the number of machines will determine whether or not it will pay to employ an engineer to manage the moving. Generally some member of the organization, who is well acquainted with all the machinery, is given control of this work. If the move is not great, this may prove to be the better plan, but, as a general rule, the men in the organization are not experienced in moving and their other work must be neglected. The number of engineers experienced in moving factories is limited. To be successful in this work, a man should be a mechanical draftsman, familiar with the forms and terms of architectural drawing, and have had practical experience in production along the same line as the factory to be moved in order to adjust and locate the machines so as to get the best results. He should also have had experience as head millwright or master mechanic, so as to be entirely familiar with all kinds of overhead construction, motors, lineshafts, countershafts, etc.; he must have the faculty of getting along with everyone with whom he comes into contact, and must be willing to accept suggestions from everybody, even from a laborer. In case a man with no previous experience in moving is employed, it may be profitable to employ an experienced man in a consulting capacity, if for only a single interview.

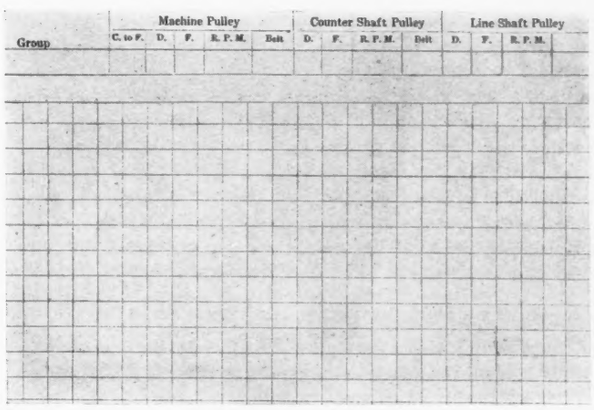


MACHINE RECORD

Machine			No.
Used			
Old Bld'g Dept.	Floor	New Bld'g Dept.	Floor
Maker		Size	Capacity
Purchased from			Maker's No.
Contract No.		Cost of Machine	
Purchase Order No.		Cost of Attachments	
Date of Installation		Cost of Installation	
Inventory value as of June 30		Total Value at Installation	
1916	1920	1924	1928
1917	1921	1925	1929
1918	1922	1926	1930
1919	1923	1927	1931

Form No. 325-1M 6-17

Fig. 1. Machine Record Card



Group	Machine Pulley					Counter Shaft Pulley				Line Shaft Pulley		
	C. to F.	D.	F.	R. P. M.	Belt	D.	F.	R. P. M.	Belt	D.	F.	R. P. M.

Fig. 2. Back of Machine Record Card

Planning the Moving

The best time to start planning the moving is before the plans or drawings of the building are finished, in order that the machinery may be laid out to give the best results of production. In one case, where the plans of a factory, approximately fifty by two hundred feet, were completed and the building was being constructed before an engineer was employed to take charge of the moving, it was found that the most economical location for the screw machine department was in the rear of the building. After laying out these machines on paper, the engineer discovered that they would require about five bays of the building; but the architect, in laying out the building, had located a large sliding door in the fifth bay, thus making it necessary to separate the screw machine department into two groups, one on each side of the large door. As they were bar machines, it was necessary to locate the first about ten feet to the right of the door, so that the long bars of stock would not project into the space directly in front of the door. Had the machinery lay-out been made before the architect had completed the plan of the building, he could easily have placed this door one or two bays nearer the center of the building. In another case, the architect located three vent pipes at approximately equal distances from each other in a floor to be used for laying out and cutting large patterns of heavy cloth and canvas. As these pipes interfered with the placing of the large tables upon which the material was to be laid while marking out, it was necessary to change their location, which involved a costly change in the plumbing. This expense and trouble would have been entirely avoided had this department been laid out before the building drawings were made.

When an engineer enters upon his duties, the manager or someone else in authority should introduce him to all superintendents, foremen, and other heads of departments, so as to eliminate all chance of friction and to secure the complete cooperation of everyone during the moving. The engineer should then make himself familiar with the entire organization and all of its systems, as well as with methods of machining and routing of material, in order to do his own planning. Too much stress cannot be laid on this point, for it is during these days, while the engineer is becoming acquainted with the different heads of departments, that he lays the foundation for the cooperation he must receive during the moving if his work is to be a success. He must become familiar with all the details of the new building, by a careful study of the plans, and should visit as many other factories as is possible, to study the latest ideas in factory lay-out, overhead construction, machine drives, piping arrangements, lighting in special cases, methods of handling stock, etc.

At this time it must also be decided how much planning is to be done, whether only the location of the machines and lineshafting are to be considered, or whether the location of the countershafts and motors are also to be fixed. The first way is the quicker and cheaper from the planning standpoint, but costs more later, because the millwrights erecting the machines must plan the arrangement of the countershafts and

[1] Superintendent, Van Dorn Electric Tool Co., Cleveland, Ohio.

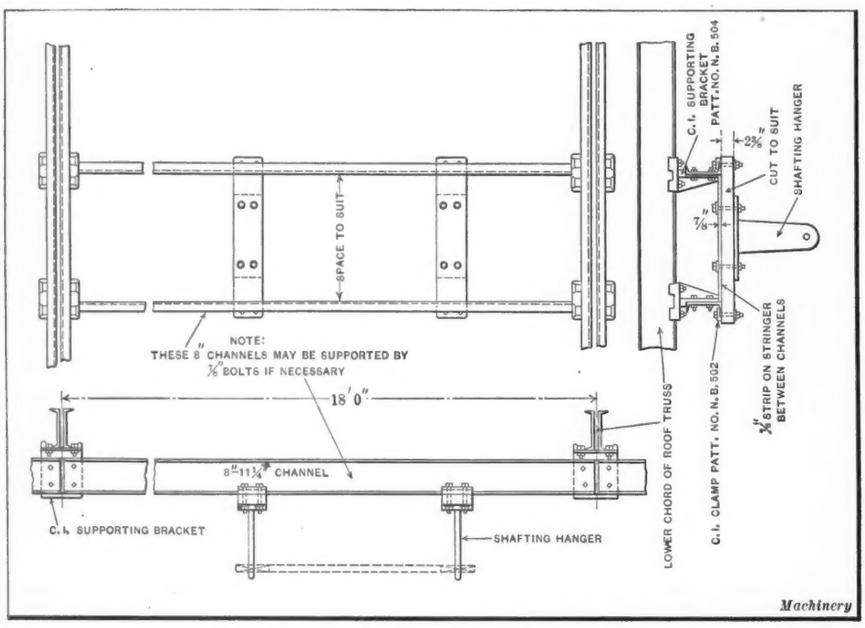


Fig. 3. Supports for Lineshafts and Countershafts

motors. This method not only requires a better class of millwrights but it retards the progress of the moving and frequently results in overhead interference that cannot be overcome and thus causes a change in the plans. The second way costs more when the plans are being made, but is much cheaper later, and reduces to a minimum all interference with overhead work, wiring, piping, etc. As a general rule, when the millwrights encounter difficulty with the overhead construction, all work must stop until the point in question is settled. Besides, it is frequently necessary to move some of the machines already permanently located in order to overcome the difficulty. Sometimes the loss entailed by one interruption of this kind will more than pay for the planning of all the overhead construction.

Moving a Plant to Another Location in Same City

The following is a description of the method used when moving a plant from one location to another 1.3 mile away. The factory contained over 600 machines, ranging in size from a sensitive drilling machine to a 100-inch vertical boring mill, and owing to the nature of the contracts in force, it was necessary to keep up the production while the move was being made. First, a complete set of floor plans was made to a scale of one-half inch equals one foot. These plans showed the outline of the walls with windows, doors, and columns, and all fixtures such as elevators, stairways, drinking fountains, etc. Then sketches were made of all the machines, both power- and hand-operated. These sketches showed the outline of the machines and the exact location and the rotating direction of drive pulleys. They also contained notes covering all items of special interest, such as sewers required for pits for shavings or turnings, pits for clearances for machine parts, water pipes, electric wire connections, air systems, and individual cranes. In case the machine was driven by an individual motor, a note of the location of the switch or controller was made; a note was also made of any special space required around the machine on account of the stock condition. Frequently when one machine in a progressive group is slower than any of the others in the chain, there is a congestion of material at this place. A memorandum was also made of any special feature that the foreman or operator thought would increase production or make operations easier for the operator; the handiest spot where the tool trays could be located was noted, and a cross was placed to show where the operator usually stood.

When these sketches were completed, sketches were made of the countershafts of all the machines. These sketches contained only enough dimensions to locate the shafts in the proper relation to their respective machines. The essential dimensions, of course, vary on different types, but usually they are the over-all dimensions, the drop of the hanger, and the relation of the cone pulleys or any keyway pulley to the end of the shaft. As the sketches of the machines and countershafts formed the basis of all plans, practical millwrights did all the measuring in order to have the measurements as accurate as possible. One of these millwrights was to have charge of all the erecting in the new factories; in this way he became familiar with the special features as they were installed in the old factories.

The value of the information collected by a planning engineer depends largely on its arrangement and the ease with which it may be referred to. Fig. 1 shows the front and Fig. 2 the back of a machine record card, upon which can be placed all the information pertaining to any machine. This card is self-explanatory, with the exception of the second column on the back; the heading C to F means distance from center of drive pulley to floor, which is a very important dimension when planning overhead construction, as it determines the angle of the belt from the machine to the countershaft. The rest of this side may be used for sketches of the machine and countershaft and other information. This card may be used as a permanent inventory card and in the superintendent's office as a reference card; it is very helpful when ordering repair parts for any machine.

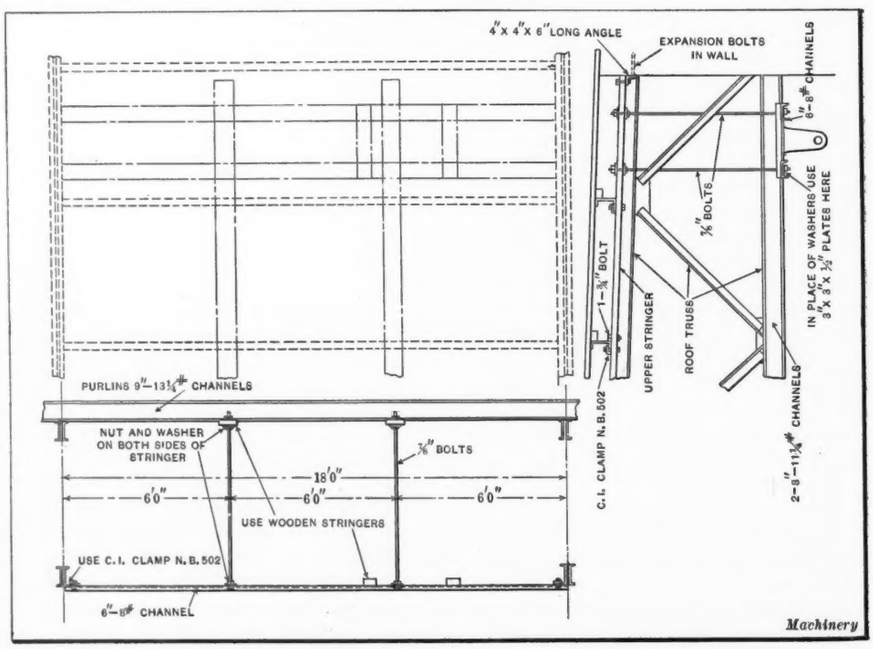


Fig. 4. Supports for Lineshafts and Countershafts running Lengthwise of Middle Span

TABLE 1. MOTOR DATA

Location in New Plant	Motor Required, Horsepower	Motor Used			Taken from
		Horsepower	Serial Number	Shop Number	
Mill gear basement, west end of building	10	10	1,831,575	628	Stock
Rear of mill gear, northeast of Column 12, south, center	10	10	455,799	604	Stock
Rear of mill gear, grinding room	5	5	.....	...	Stock
Mill gear, running machine No. 83, northeast of Column 11, south, center	10	10	716,055	606	Running machine No. 83 at present
Mill gear, grinding department	10	10	736,510	612	Running machine No. 43 at present
First floor, grinding department, southwest of Column 9, north	10	20	1,839,576	639	Stock
Second floor, spur gear department, north of Column 1, north	10	10	1,034,571	611	Turning lineshaft in spur gear cutting department
Second floor, Fellows gear shaper department, north of Column 1, south	15	20	19,662	623	Turning lineshaft in Fellows gear shaper department
First floor, tool-room, northwest of Column 1, south	5	5	170,918	613	Driving machine No. 233
Second floor, tool-room, southeast of Column 5, south	5	5	468,884	616	Running lineshaft in tool-room

Machinery

Next, templets of white cardboard, 1/32 inch thick, were made of all the machines and countershafts, to a scale of one-half inch equals one foot, and all the information noted was transferred to them. The idea was to have all information before the planning engineer at all times.

General Lay-out of New Plant

A general lay-out was next made of the various departments as they should be located in the new plant so as to get the best results in the production and routing of material. This lay-out was submitted to the persons in charge of the various departments, and all their criticisms were considered before any actual laying out of the machines was begun. Afterward the machines, countershafts, lineshafts, motors, etc., were located, each machine being considered by itself. By this plan a much better lay-out is obtained, because the machines have so many things in common that must be considered in order to get better results before starting the actual locating of the machines. Some of these are the general location of lineshafts, number of revolutions per minute of lineshafts and countershafts, type of hanger, whether ball, roller, etc., belt speeds, and maximum and minimum pulley diameters. As soon as the locations of the lineshafts and their motors were determined, they were drawn on the lay-out plans with pencil. The final lay-out of all machines was accomplished by moving the cardboard templets of the machines and countershafts around on the drawing-board, the templets being held in place on the board by small tacks. After what was considered the best possible lay-out was obtained, it was submitted to all persons concerned for their approval. The embodiment of the suggestions thus obtained greatly improved the lay-out. In most departments it was necessary to make many changes in the original plans before everyone concerned was satisfied. When the plans were finally approved, the machines, motors, countershafts, lineshafts, pulleys, couplings, and shaft collars were drawn in.

Next the exact design of the overhead construction for holding or bolting the lineshafting, countershafts, motors, pulleys, etc., to the ceiling was planned, as shown in Figs. 3 and 4. This was done in a general way before the building was erected. Each type or style of overhead construction was called a case and was designated by a letter; each construction print had a note specifying which case was to be used. From the complete floor lay-out, the millwrights were able to get all the necessary information regarding the location of machines, motors, countershafts, lineshafting, and size of pulleys. Data on the motors

TABLE 2. DATA OF LINESHAFTING, HANGERS, COUPLINGS, AND COLLARS

Lineshafting					Hangers			Couplings		Collars	
Location in New Plant	Diameter, Inches	Length		Remarks	Number	Drop, Inches	Remarks	Number	Remarks	Number	Remarks
		Feet	Inches								
First floor, grinding department, north of Columns 8, 9, 10	2 7/16	24	0	New	8	14	New	2	New	2	New
	2 7/16	16	0	New							
	2 7/16	20	0	New							
First floor, bevel gear testing department, north of Columns 4 and 5	2 7/16	14	6	Use 18-foot length of new shafting	3	12	From street railway department	0	....	2	New
First floor, burring department, north of Columns 6 and 7	2 7/16	20	0	First floor, street railway department, north of center aisle	3	12	From west end of building	0	....	2	New
Second floor, screw machine department, south of Columns 6, 7, and 8, north	2 7/16	20	0	First floor, east end, motor gear department, 20 feet 5 inches length	6	19	New	1	New	2	New
	2 7/16	16	0	Second floor, Fellows gear shaper department							
Second floor, screw machine department, south of Columns 9 and 10, north	2 7/16	24	0	Second floor, Fellows gear shaper department	7	19	New	2	New	2	New
	2 7/16	14	0	New							
	2 7/16	10	0	New							

Machinery

were tabulated as shown in Table 1, and all data on lineshafting, couplings, and collars were arranged as shown in Table 2.

Organization for Handling the Moving

In the present instance, the engineer was responsible for the entire move, but an assistant had charge of the draftsmen who made the drawings, sketches, etc. The assistant also made out most of the requisitions for material and looked after the material tracers. On a move of any size, the tracing of material requires a man of action and experience, for unless the material arrives according to schedule, the plans made beforehand will miscarry.

At the old plant there was a dismantling and a moving gang. The dismantling gang prepared all machinery for moving. As a machine was dismantled, there was fastened to all loose parts a tag upon which was written the number of the machine, and all these parts were placed in boxes, one box for each machine. These boxes varied from 2 feet wide, 4 feet long, and 18 inches deep to 3 feet wide, 10 feet long, and 2 feet deep. The top board on each long side extended beyond the box about two feet, making the boxes easier to carry and making it possible for the heavier ones to be handled with a crane. It was the duty of one man in the dismantling gang to see that each and every part that went into these boxes was tagged.

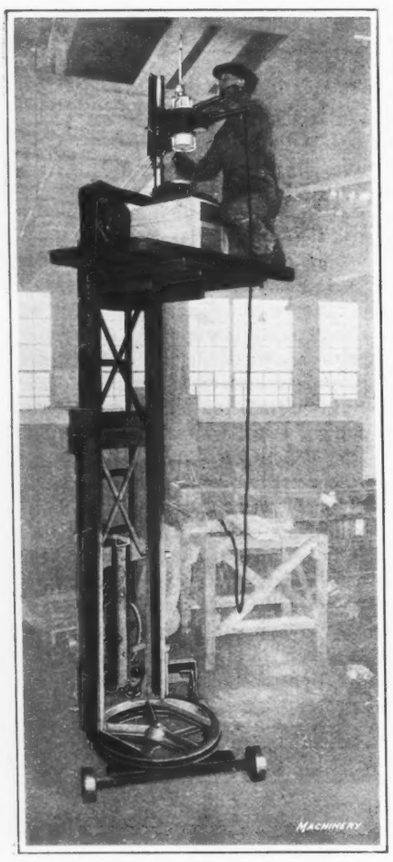


Fig. 5. Use of a Revolvator for drilling Holes in Ceiling to install an Overhead Motor

The moving gang was obtained from a regular machinery moving company, which supplied the men and the auto trucks. It was the work of this gang to place the machinery on the trucks and haul it to the new factory. This machinery was received at the new plant by a gang whose duty it was to unload as rapidly as possible, thus keeping the trucks on the road all the time. The dismantling, moving, and receiving gangs had lists of machines and the order of moving each day, so that the gang bosses would have the proper trucks ready for the machinery.

All machinery was taken from the receiving gang by the locating gang, who took it to its permanent location. This gang had blueprints showing the permanent location of all machines. This gang also removed all parts of each machine from the boxes and placed them at their respective machines.

The erecting gang comprised three groups: a lineshaft and overhead construction gang, a countershaft gang, and a machine leveling gang. The lineshaft and overhead construction gang erected all overhead construction except the countershafts, which were erected by the countershaft gang. The machine leveling gang located machines as called for by the blueprints and secured them to the floor or foundation. All belts were installed by one man and two helpers.

It should be the aim of every man in charge of a move to obtain as much speed as is possible. He must, therefore, devise and use every short-cut and appliance that will speed up the work in any way. Every move brings out several new ideas, as well as improvements on the old methods. The greatest time-saver used in the case described was an appliance called a revolvator, made by the Revolving Portable Elevator Co., Jersey City, N. J., which is an elevating truck made of structural steel which has a platform that can be raised or lowered by means of a crank. By fastening a cradle to the platform, in which the lineshafting, countershafting, and motors were laid, one man was able to raise them to the proper position on the ceiling. Even in the case of a motor weighing about 1500 pounds, all that was necessary was to put the motor in the cradle and then hoist it to the ceiling, mark the holes on the ceiling, and lower the platform a few feet, or enough to allow the drill to be used for drilling the holes in the overhead construction, after which the motor was hoisted again and bolted to the overhead construction. This machine was also used in moving small lathes up to 2000 pounds. All that was necessary was to run it under the base of the lathe and then raise the platform enough to lift the machine from the floor. The overhead drilling was done by Van Dorn portable electric drills, as shown in Fig. 5. The heavy machinery was moved about the factory floor by means of small four-wheeled dolly trucks equipped with ball-bearing casters. All the light machines and boxes were handled on standard trucks having two large wheels and one swivel wheel on each end. The bulk of the stock, forgings, and castings was moved on one of the regular platform trucks.

* * *

STEEL FROM NICKEL-COPPER-IRON ORE

Large-scale experiments show that a metal giving test results equal to those of nickel steel such as is used for bridges and forgings can be produced at low cost from the Sudbury ores in which both copper and nickel are combined with the iron. According to a paper read by Lieutenant-Colonel R. W. Leonard before the Canadian Society of Civil Engineers, the new product has been named "Nicu" steel and is to be made by the Nicu Steel Corporation; this steel, however, has not yet been manufactured on a commercial scale. It has an ultimate strength of from 70,000 to over 100,000 pounds per square inch, a yield point of from 50,000 to 80,000 pounds per square inch, and satisfactory ductility for bridge or ordnance purposes. It may be produced for from $30 to $35 per ton. G. M. Colvocoresses made the original experiments and worked out processes for smelting the Sudbury ores or the slags now wasted in that district and took out patents on the processes. Subsequently, he and H. A. Morin smelted 200 tons of ore and 40 tons of slag in an improvised plant at East Montreal. After roasting, smelting with lime flux in an electric furnace performs the principal reduction. The pig iron thus obtained is of homogeneous composition and is refined to medium carbon steel partly in an electric furnace and partly in an open-hearth furnace using producer gas.

In ten of the heats, the steel contained from 0.17 to 0.73 per cent carbon and from 0.012 to 0.032 per cent silicon; the sulphur was always below 0.048 per cent and the phosphorus was generally below 0.01 per cent. The sum of nickel and copper ranged from 1.25 to 2.5 per cent, the copper usually being about one-fifth of the total. A test made by Dr. Alfred Stansfield, of McGill University, Montreal, showed that "Nicu" steel containing 2.26 per cent combined nickel and copper has a tensile strength of 96,500 pounds per square inch, a yield point of 52,800 pounds per square inch, an elongation in 2 inches of 24.2 per cent, a reduction of area of 50.8 per cent, and a 180-degree bend test without cracking. Three and one-fourth per cent nickel steel is commonly specified to have an elastic limit not below 50,000 pounds per square inch and an ultimate strength of 85,000 to 100,000 pounds per square inch with an elongation of 16 to 17 per cent in 8 inches and a reduction in area greater than 30 per cent.

* * *

According to an arrangement with the Fuel Administrator, the manufacturers of common window glass will make this year only one-half of their 1917 output. This reduction will mean a saving of 500,000 tons of coal and the removal of at least 18,000 carloads of freight from the railroads.

INSPECTION METHODS OF THE FUTURE

BY C. C. MARSH[1]

Successful manufacturing demands not only modern machine tools, a well-trained force of operators, and a sales organization that can put the article on the market and create a demand for it, but also an efficient inspection system. When a product that is to be absolutely interchangeable is to be manufactured, the measurements on all parts of one kind must be exactly alike as far as it is possible to make them.

Many manufacturers have failed to produce parts that are absolutely interchangeable because they have not entirely solved the inspection problem. Some of these manufacturers have been striving for years to solve this problem, but a number have failed to see the importance of automatic inspection. Accurate inspection is necessary to insure accurate machining, for the closer work is inspected, the more errors are found; and finding the latter, even in small numbers, gives the motive to correct, so that there is less chance for the error to be made again. It is also obvious that, though it is necessary to machine parts very close to the desired limits to guarantee interchangeability, unless the greatest skill is used in the inspection, variations are sure to pass and some parts will not fit. While it is possible to obtain machine tools that will turn out work with a great degree of accuracy and a small percentage of error, when errors do occur they are small and difficult to find, so a skillful inspector is needed, which increases the inspection costs.

The only remedy for these conditions seems to be to employ inspection methods that will not depend on the human senses; in other words, the inspection must be mechanical and automatic as far as possible. The ability of an inspector varies with his physical and mental condition, and an instrument, be it ever so accurately adjusted, that depends on his skill is not any more unfailing than he. There are also some conditions of the natural elements that are seldom taken into consideration by the average inspector, no matter how skillful. So if the rapid production of parts that are absolutely interchangeable is desired, the human element in inspection methods must be reduced to a minimum.

Competition is a great factor in the demand for more rapid and accurate inspection methods. The fact that many manufacturers are making the same article, and are striving to produce the greatest quantity for the least cost in order to undersell their competitors, must ultimately result in the least possible number of inaccurate parts appearing in their products and in every part of the same kind being alike; mechanical inspection is the only means by which this can be finally accomplished. Various concerns engaged in such work have employed women as inspectors, but it takes much time and money to train women to become proficient in this line; besides, the human element is present. Other concerns are trying to replace women with automatic and semi-automatic inspection machinery and equipment, and some have succeeded.

It must be remembered, however, that in general manufacturing, mechanical inspection is no small problem. While various devices have been designed to do all that the human eyes and hands can do, there always remain operations that must be done by hand. Some of the simplest devices have been the result of months and years of study of inspection needs and conditions; so the general development of mechanical inspection methods will be slow on account of the varying conditions thus encountered.

In the manufacture of automobiles, semi-automatic inspection devices have been tried with more or less success. The real advantage of these experiments has been shown in war manufacturing in such lines as airplane motors, gun parts, hand grenades, shells, fuses, and various other products where interchangeability and duplication are essential factors. The improved methods of machining parts in great quantities, which have caused radical departures in jig and fixture design, form another factor that is causing the demand for automatic inspection. Work turned out so rapidly that it must have an army of inspectors to handle it properly must be inspected more rapidly than is now generally done, and also with less human help and chances of error. The advantage of machine inspection lies in the fact that each part is inspected in the same manner and impartially.

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Important Features in Design

One necessary and important detail must be remembered in designing an automatic inspection device. As even the hardest materials wear out in time, all contact surfaces must have some compensation for wear. Such surfaces may have springs and adjusting screws so arranged that the surface in question will have a constant pressure; in some cases it is possible to use weights, which are often better. There is practically no limit to the means by which an automatic device may separate the correct from the incorrect parts. The general idea so far is to have contact points that, on certain pressure or travel, will operate a mechanism that controls gates or openings in such a manner that various sizes are separated; in other cases, these contact points open or close electric circuits that are connected to incandescent lamps. Electricity, in fact, may be used in many ways, both to operate and to control these devices. Complication in design should be avoided; in fact, complicated design has been the main obstacle in the development of automatic inspection equipment.

Operation of Inspection Devices

The agents employed to operate automatic inspection devices are vacuum, electricity, compressed air, water, and steam. Water has been used for some time to test gasoline-engine cylinders for leakage. The cylinders are filled with water, which is then subjected to a much greater pressure than that which will be in the cylinders in actual use; in fact, the pressure is so great that, if the castings are porous, water will be forced through the cylinders. Water has also been used for some time on other products where an air-tight and waterproof material is desired.

Compressed air is used so often that it is practically unnecessary to mention the many purposes for which it is adapted; rubber products are only some of the many. Vacuum is not so often used, as it is not possible to obtain a pressure great enough to be applicable to general demands. It is, however, used successfully for inspecting solderless tin cans to insure that they are non-leakable. The machine works on a very simple principle and is operated on about one-half of the maximum vacuum that it is possible to obtain. It consists simply of a wheel, approximately sixty inches in diameter, on the periphery of which are placed soft rubber pads of a good quality that are a little larger in diameter than the can. Each pad has a hole in the center, from which rubber tubes lead to a rotating valve fitted to the hub of the wheel. The wheel is mounted on ball bearings, which are fastened in supports long enough to raise the wheel so that it will revolve. The wheel is driven by a 1/4-inch round belt from a countershaft at very slow speed. The vacuum is obtained by an electrically driven pump, the connections being fitted to the hollow hub of the wheel and thence to the rotating valve.

The cans are placed on the pads by girl operators as the wheel slowly revolves. If there is no leak in the can, the vacuum causes it to remain on the wheel until the latter has revolved far enough to come in contact with a trip, which closes the valve for that pad; then the can falls into a chute provided for that purpose. If a leak is present, a faulty seam being generally the cause, the can will either not stick at all or else it will not stay on the wheel until it has traveled far enough to enter this chute. In this case it is carried away by another chute, and later is tested by compressed air and the leak found and corrected. The concern using this device designed and built it in their own plant, and it is entirely independent of the human element. In this case the inspection requirements were studied and analyzed, and although the machine was perfected only after many trials and experiments, when the necessary result was obtained the design was simplified and the efficiency increased. It is needless to add that this machine has many times paid for itself in the cost of skilled inspectors, time, and wasted material that it has saved. Showing with unfailing accuracy the exact percentage of spoiled work, it created the motive to improve the product.

Where mechanical devices are to be used to measure diameters and lengths accurately, care must be taken to eliminate chances of error caused by dirt, chips, or other foreign matter getting between the contact surfaces and the surface to be measured or gaged. This may be done in some cases by washing before inspecting. Another obstacle to mechanical measuring must also be taken into account. When steel or nickel stock is machined rapidly, it may become slightly magnetized, so that small particles of mineral dust and chips will adhere to it. This can only be overcome by eliminating, as much as possible, the friction of the cutting tools by using the proper lubricant when machining or by demagnetizing the part after machining. When this condition is overcome, there is less chance of error in mechanical measuring.

Electrical contact devices may be adapted to many uses and can be used in many assembling operations. One such device is often used to test the timing of gasoline motors, the contact points lighting lamps on the opening or closing of the valves. This device is contained in a small portable box, which contains a battery and a socket for a six-volt lamp. Wires about a foot long connect the battery with the motor, one wire being fastened to the valve stem and the other grounded to the motor. The mechanism is so arranged that the contact will be made only when the valve lifts from the seat, thus showing the exact timing. The complete outfit will not cost over twenty-five dollars. In place of the battery, ordinary electric current can be used and a lamp with a higher voltage can be employed.

There is no doubt that at some time in the future, on account of the constant demands now being made for rapid and accurate production, there will be evolved from the many ideas now being used a measuring device that will solve some of the inspection problems confronting American manufacturers. This instrument will probably be one that can be used in many ways; it will in no way depend on the skill of the operator and will leave no doubt as to its accuracy. It will have no master, that is, it will be its own standard, and will not have to be tested constantly in order that it will maintain its accuracy. Ten years ago, accuracy in ordinary manufacturing that is now quite common was considered impracticable. The real cause for the improvement is the demand for more accurate and a greater variety of measuring and inspection tools. The trade schools also are making a greater effort to familiarize themselves with modern inspection methods in order to be able to give the student a better education on this subject. With the proper talent bent in this direction, there is good reason to expect that the eventual result will be inspection on a scientific basis, mechanically, and without depending on the skill and senses of the trained operator.

* * *

Statements to the effect that the explosive force of dynamite acts downward are often seen. This statement, however, is entirely erroneous. Arthur LaMotte, manager of the technical division of the E. I. duPont de Nemours & Co., Wilmington, Del., explains the reason for this common fallacy as follows: When dynamite was first used, its action was so much quicker and more powerful than black powder that a sufficient fraction of its explosive force would fracture a rock when the dynamite was placed on top of it. Any explosive exerts its power equally in all directions, and the gases produced in consequence of the explosion seek to escape in the line of least resistance. While it is true that when a charge of dynamite is placed on top of a rock it will frequently break it, it would be found that it would break it just as easily if it were placed either on the side or on the bottom of the rock. Nitroglycerin, which is the active component of dynamite, changes almost instantly into gaseous form, and the gas is evolved at several thousand feet per second. In fact, the gas is evolved at such an extreme rapidity that the column of air above it is compressed to such a degree that it acts as a confining material, and hence much of the energy of the explosive is expended upon the support upon which it rests. A 60-per-cent nitroglycerin dynamite exploded in the open will develop nearly as great a velocity of detonation as when confined in a bore hole, and has a velocity of nearly 20,000 feet per second.

SAFETY AS AN INVESTMENT AND WAYS OF SECURING IT

BY H. P. HEYNE[1]

Safety first is a business proposition that may be considered from a financial as well as from a humanitarian standpoint. Every time an employe is injured and must be replaced by a less efficient worker, it entails an expense of from $50 to $100 to break in the new man. If a firm employing 5000 men has 100 time-lost accidents per month, or a total of 1200 cases per year, this will mean a total loss of $60,000, based on $50 per man.

By a systematic safety campaign, however, the number of accidents can be reduced. If a reduction of 25 per cent is effected during the first year of the safety campaign, there will be a saving of $15,000, together with a higher percentage of efficiency for the plant. Even though $10,000 may have been expended during the year in the installation of safety devices, etc., there still will remain a saving of $5000, a body of more contented workers, due to the fact that they have been considered along welfare lines, and a less disorganized force through a reduction in labor turnover. The saving will increase annually by a still further reduction in accidents.

Maintaining a record of the causes of accidents, together with the percentages for all classes, gives a working basis for ascertaining what class of accidents is the most common. Then attention can be effectively directed toward these for corrective measures. It will often be found necessary to show the men just how to hold and work with tools, as the majority of injuries are due to the lack of ordinary care on the part of the injured or a fellow-employe in the discharge of his duties. The foremen have an important part in the safety movement and should teach the men safe practices, as they are held responsible for the injuries to the men under their supervision.

The introduction of safe methods and the installation of safeguards has a double purpose: First, it is necessary to effect a reduction in accidents; second, it shows the men that the firm has an interest in their welfare and is in earnest, and this knowledge is bound to make the men ambitious in accident prevention work. A man without ambition is not a desirable employe.

The men may be made enthusiastic over the safety measures by appointing them on plant safety committees and encouraging them to suggest safeguards and changes that will be beneficial to the company as well as to themselves. Many good ideas will be brought forth through this medium, and when the men observe that a certain guard has been installed or a recommendation accepted, they will have a feeling of satisfaction because they were consulted in the matter and will feel that they are a part of the organization, which will make them enthusiastic in the movement. Appreciation, cooperation, and enthusiasm are dominant factors in safety educational work.

Some of the little things that play a big part in the reduction of accidents are: Knuckle guards for wheelbarrows and trucks to prevent hand injuries when going around short corners; goggles properly fitted to conform with the men's faces; safety handles on crane hooks to prevent men's hands from being caught between the hook and the material; safety feet for portable ladders to avoid slipping and falling; red lights over danger signs so that employes working at night may be aware of the danger; safety shoes to protect men's toes from falling tools, etc.; soaking sledges in oil to prevent the handle in the eye of the sledge from drying out and becoming loose; proper goggles for various classes of work; checking drawings for safety; track clearances to avoid obstruction to trainmen, etc.; fire inspection to observe that hoses, fire plugs, and extinguishers are in good condition; danger tags to be attached to equipment temporarily out of order—such equipment should not be used until the tag is removed; proper piling of material to prevent falling on workmen; good order—a place for everything and everything in its place; proper care of pneumatic hammers to prevent injury; and proper installation and guarding of grinding wheels and other moving parts.

[1] Safety Inspector, United Alloy Steel Corporation, Canton, Ohio.

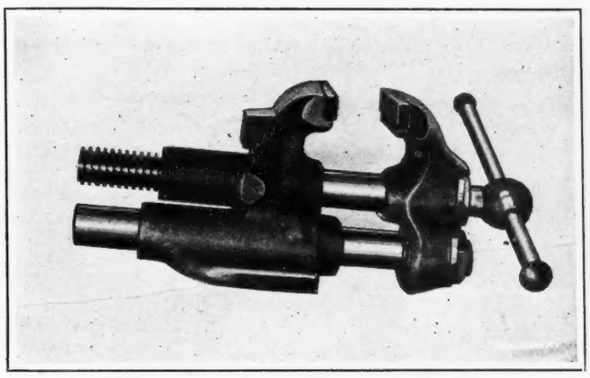

Fig. 1. Bench Vise made in a New Zealand Trade School

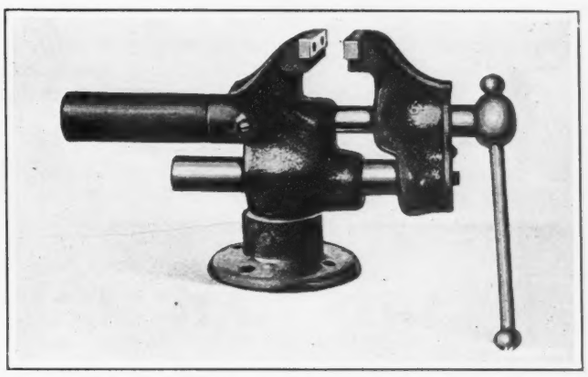

Fig. 2. Another Bench Vise made in the Trade School

A NEW ZEALAND SCHOOL WORK-SHOP

BY JOHN PEDDIE[1]

The accompanying illustrations show a few of the products of the evening school of the Technical College at Christchurch, New Zealand. Though the students are apprentices in various branches of the engineering trades, in many cases their evening school tasks are the only work these students do with machine tools. Some of them are in the electrical trades and do little work beyond wiring, some are engaged in the assembling of agricultural implements of the roughest kind, and some are restricted to one branch of machinist's work and will complete their apprenticeship with very little experience. To such young men, the evening school course is a valuable addition to their training, and they acquire familiarity with work-shop processes that would otherwise appear full of mysterious difficulties. They are shown how to use machines they are not allowed to touch in their employers' shop and how to do varieties of work that do not come within their employers' range of business.

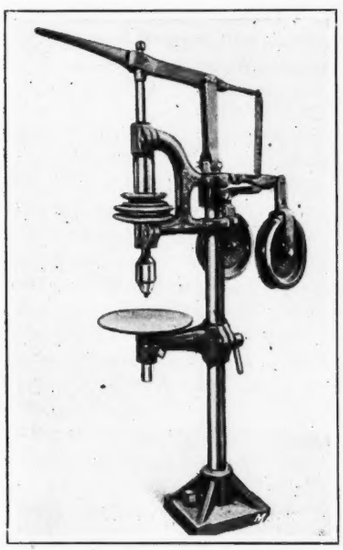

Fig. 3. Small Foot-power Drilling Machine—a Trade School Product

Some employers do not approve of this feature of the work. They say that the students should be taught to do their everyday work more rapidly, apparently being indifferent to the question as to whether at the end of five years they can claim to have taught their apprentices "the whole art and mystery" of the craft. In the past, this agreement was stated in the indenture; nowadays, while it may be implied, it is tacitly ignored. When a creditable piece of work, such as the surface gage shown in Fig. 4, is shown to critics of this type, they ask, "Ah, but how long did he take to make it?" Perhaps the lad who made it has done nothing in the shop in which he is employed except run a screw machine or drilling machine, or chip castings. The advice of Oscar Beale, in Brown & Sharpe's handbook, applies to this:

"During the first few weeks, it is well for a young apprentice to do his work of a quality about as high as he is capable of doing. After he is sure of the quality of his work, he can have a thought as to the quantity."

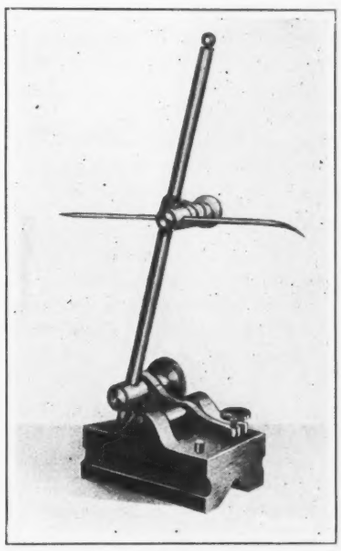

Fig. 4. Surface Gage made by Boys in New Zealand Trade School

As the time spent in the school shop does not amount to more than a few weeks' time in a commercial shop, it would appear that quality should be the chief aim. The students do not make more than one example of each class of exercise. They nearly all make a surface plate, 3 by 6 inches, or 6 by 6 inches, and in doing this get probably the only experience they will have for years of preparing a true plane surface by scraping. During this exercise, they learn

[1]Address: Technical College, Christchurch, New Zealand.

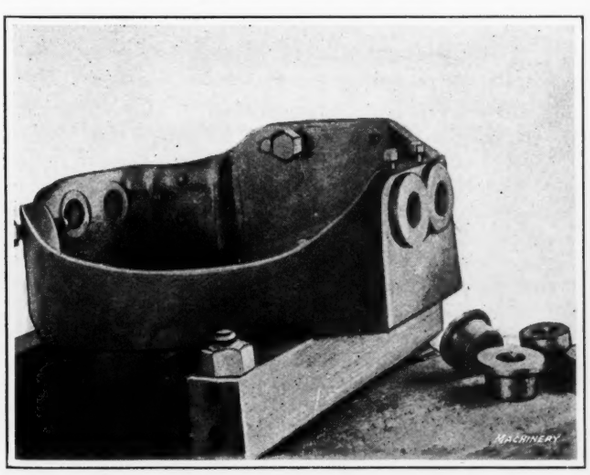

Fig. 5. Jig used when boring Vise shown in Fig. 1

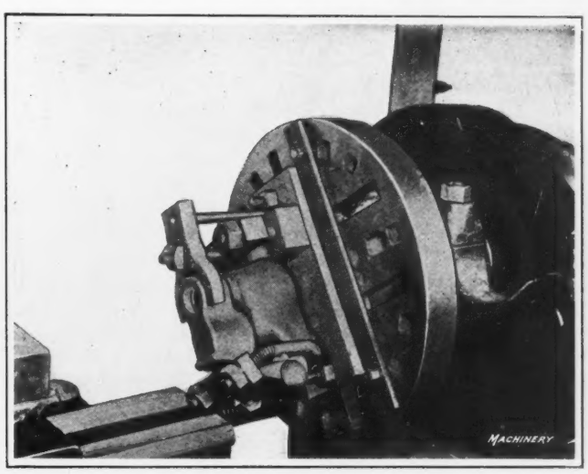

Fig. 6. Boring Vise on Lathe Faceplate

how to sharpen a scraper and how to dress and harden it when necessary. In other exercises, they learn to bore straight and taper holes, to turn and grind straight and taper spindles, and to cut screw threads. The ball on the end of the vise screw is finished with a hand graver; this is often the introduction of the student to such a tool, and frequently elicits a look of pleased surprise at the ease with which it can be used.

The vise shown in Fig. 1 has 4-inch jaws and the castings are bored while clamped in the jig shown in Fig. 5. The vise shown in Fig. 2 has 3-inch jaws, and is bored while held on a lathe faceplate, as shown in Fig. 6. The screws of both vises are protected with covers, that of the vise shown in Fig. 1 being removed. The small drilling machine, Fig. 3, was designed by the writer. The spindle bearings are babbitted, parallelism with the column being secured during this process by a very simple jig; the guide pulleys are free to adjust themselves without side pressure when the drill is being driven by foot power. The base and fine adjustments of the surface gage shown in Fig. 4 were also designed by the writer; quite a number of these gages have been made, and they afford a large variety of exercises.

Students attending the machine drawing class, as well as the work-shop, are required to make drawings of any piece of work they undertake in the shop. In some cases they also make tracings and blueprints for shop use. Before a student is allowed to attempt a project of his own design, he must produce a satisfactory drawing or sketch of it.

* * *

LEGAL DUTIES OF EMPLOYES

BY CHESLA C. SHERLOCK[1]

A great deal has been said and written concerning the duties which an employer owes to his employes, but very little is said concerning the legal duties of employes. Whether these duties are taken as a matter of course or whether they are implied in each case is not known. It is true, however, that very few employers know definitely just what duties their employes are bound by law to perform. In a general sense, the employe's services belong to the employer during the hours of the employe's employment, but whether a failure on the part of the employe to devote his entire time to the employer's service constitutes a breach of the contract of employment depends, as a rule, upon the circumstances of the particular case. If a man is employed at a given wage to make horseshoes, he has no right to take time off from his regular work to make wagon tires for another. This fact is too well known among employers to be further emphasized, but when we get into the more complex relations that arise in everyday work, it is not so easy to dispose of the cases.

Employes' Obligation to Obey Rules

It is implied, as a part of every contract of employment, that the employe shall obey the lawful rules, orders, and instructions of the employer, at least as far as they are reasonable and not merely arbitrary or capricious. This question of obedience to orders has called out legislation in some of the states. Where workmen's compensation acts are in force, a disobedience of an employer's order or rule will not be sufficient to deny the workman the right to recover compensation from his employer, unless such disobedience shall amount to "serious and willful misconduct" on the part of the employe. If an employe refuses to obey a reasonable rule or order of his employer, the contract of employment may be terminated then and there, even though nothing was said in the contract itself regarding such obedience. This statement of the rule must, of course, be subjected to some modifications.

The employe is not, however, bound to obey rules that he has not contracted to observe or that are not incident to or assumed by him in the general scope of his employment. Before he can be deemed to have been bound by a rule it must appear that he was cognizant of its terms. It is plainly the duty of employers, then, to publish their rules in such a way that they cannot fail to be brought to the employe's attention, if strict obedience of the latter is to be required. It is perfectly logical to say that no man can be required to do a thing of which he knows nothing or has no opportunity of knowing.

Employers' Right to Employes' Time

Where an employe sells his entire time to his employer, he has no moral or legal right to devote part of his time to an independent calling or business of his own, regardless of the fact that it may not interfere with his service to his employer. If he does so engage in outside work, his employer is entitled to his earnings therefrom. This rule is clearly illustrated in the case of a school teacher who made a practice of giving special tutoring to pupils after school hours. In the course of a year, he built up a very profitable business on the side and the school board employing him finally brought suit against him. He was forced to turn an amount equal to his earnings over to his employer—the complaining board. In another case, however, a college professor engaged in the coal business on the side, employing men to do the work and merely exercising supervision over their efforts. In this case, the court refused to disturb him, saying that his outside business did not interfere with the service he had contracted to render to his employer. It follows that if an employe engages in outside work to the injury of his service to his employer, that he may be held in damages for the injury done. If the profits earned in the outside business are not sufficient to compensate the employer, the latter may also recover damages sufficient to compensate him adequately for the injury done.

Right to Inventions

In the case of inventions, however, there is a different rule. The employer has no exclusive right to the inventions of his employe. Employes are not deprived of their right to inventions while in the service of others, unless they have been hired to exercise their inventive faculties for their employers. Some very bitter cases have arisen where an inventor has been hired at a stipulated salary to exercise his gifts in behalf of the employer. In nine cases out of ten, if the employe is successful in perfecting an invention, he will try to keep it for himself and keep his employer from reaping the profits. But the courts have adopted a very sane view of the matter and have held that it is the purpose, in such contracts of employment, to give the employer the fruits of the inventor's skill and that the employer has the right to such inventions as the inventor may perfect. It should be remembered, however, that where the invention of an employe arises casually out of his employment, that the employer has no right to it, unless a specific agreement had been reached prior to the invention or a valid assignment of the inventor's rights was made subsequent to it.

Where employes have permitted their employers to use their inventions, the law implies a license to the employer to continue to use the invention in his business even after the relations between the employer and the inventor have terminated, although the employe has taken out a patent therefor.

Where an employe produces a literary production, the courts are agreed that the employer has no right whatever to it unless the employe was employed for the specific purpose of making such a production.

Obligation to Preserve Trade Secrets

It is the duty of an employe to preserve all trade secrets of his employer. Courts of equity will restrain employes from making disclosures or use of trade secrets communicated to them in the course of confidential employment. The character of such secrets is immaterial. They may be secrets of trade, secrets of title, secrets of process of manufacture, or any other secrets important to the individual employer. This question of trade secrets, however, is limited to a certain degree. The secrets must not be general secrets of trade, but must be secrets of the complaining employer.

As a general proposition, then, the employe is directly liable to the employer for any damage occasioned by his negligence or misconduct, whether it be to the property of the employer or arise from compensation the employer has been obliged to pay third persons for injuries sustained by them, because of the employe's misconduct.

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The Wilt Process of Twist Drill Manufacture

By Franklin D. Jones[1]

Process in which All Machining Operations on Twist Drills, Except Grinding, are Done Automatically

An Automatic Machine is Used having Multiple Cutter-heads and a Single Stock-feeding Spindle

THE Wilt process for the manufacture of twist drills, developed during the last ten years, comprises a number of radical changes in former methods. Heretofore it has been necessary to put a drill through a number of machining operations in the course of its manufacture. The usual way, in the production of a 1/2-inch jobber's drill, for example, has been to shear off the blank to length from the long bar on a shearing machine, square the ends on a special lathe, point on a pointing machine, center, and square-center; then either finish-turn on a lathe or rough-turn on a lathe and soft-grind on a grinder; then mill the grooves on a groove-milling machine, and finally mill the clearance or relief on a clearing machine.

Many attempts have been made to shorten this process during the last ten or fifteen years, but most of them without success. One company has developed a magazine-feed machine, which combines the milling and clearing operations, but the blanks have to be prepared in advance. The Wilt machine, however, does all the machining operations enumerated above, except grinding, automatically. It applies the principle of an automatic screw machine, developed to a high degree, to the manufacture of twist drills. Briefly, the carbon or high-speed steel bars, either hot-rolled and in the condition in which they come from the steel mill, or drawn in the smaller drill rod sizes, are fed in long lengths into the automatic machine through a single stock-feeding spindle, and the blank is automatically cut off and pointed. As each successive blank is severed from the bar stock by a cutting-off and pointing tool, it is gripped by a collet in the blank carrier or work-holding turret, which has an intermittent or indexing movement in a plane perpendicular to the axis of the stock-feeding spindle, and presented, in turn, to a multiple cutter-head, which first rough-cuts the grooves, then finish-cuts them, and mills the clearance, so that all the machining operations are performed simultaneously, and a drill ready for soft-grinding is ejected from the machine at each indexing of the blank-carrier.

One of the important features of the machine, aside from the fact that it machines the drill automatically, is that it first roughs out the grooves in successive cuts, so that, when the blanks are presented to the finishing groove cutters, they take a cut of only about 0.015 inch on each side, thereby insuring a very good finish on a groove and effecting several great savings, not only in speed of production, but also in other expenses to which most drill companies are put, such as in polishing and grinding grooves. A relatively large number of teeth is used on the finishing cutters, and one or more sets of roughing cutters, to divide the amount of work of rough-grooving, so that the speed of the machine can be governed by the time required for the clearing cutters, which at the last position of the turret, mill the clearance of the drill. After this clearing cut has been taken, the drill drops from the machine. This is the only machine, so far as is known, that automatically takes successive cuts on the same groove.

Changes in Grinding

By the old process of making twist drills it is necessary that the drill blank be turned or ground to an almost exact size before the grooves are milled. This is necessary, as the blanks have to be held in close-fitting pilots or guides when milled in the single-cut groove milling machines. Drills that are milled at a very slow rate and fit very tight in the bushings are not so likely to require groove-grinding. Owing to the successive cuts on the Wilt machine, most of the stock from the grooves is removed before the blank is presented to the finishing-groove milling cutters, so that it is unnecessary to feed the blanks through close-fitting pilots or guides. Owing to this fact, blanks made from hot-rolled steel, as well as drawn stock, can be fed to the groove-milling cutters, and a smooth finish is produced in the grooves, in spite of the fact that the blank does not fit close in the pilots. In fact, the pilots on the machines are about 0.015 inch over size. It is possible to produce the larger sizes of drills without any pilots, although this is not done, as they are used chiefly for conducting oil to the cutters. The soft-grinding process is much simplified, because the clearing cutters, as well as the groove-milling cutters, have already removed most of the decarburized surface from the hot-rolled bar, and only the remaining decarburization on the narrow ridge along the groove edge is left to be removed. To do this a grinding machine has been developed, which does not require centering the blanks. This machine constitutes another interesting feature of the new process that has been evolved for making twist drills.

The point-grinding operation is necessary in the Wilt process as well as in all other processes. The novel feature of this operation by the Wilt method is that the point-grinding machine chucks the drill blank on the cleared part of the drill instead of on the outside diameter, thus assuring margins of a uniform height from the clearance. After the body of the drill has been soft-ground, the finishing processes are the same

[1]Associate Editor of MACHINERY.

by the Wilt as by other methods. These finishing processes consist in hardening, tempering, straightening, sand-blasting, stamping, and finish-grinding to size, the point finally being sharpened or finish-point ground, ready for drilling holes.

The operations as outlined constitute the general practice, which may be modified under special conditions, and is the practice followed in making ordinary jobbers' drills. In the taper-shank drills, the blank is made the same as in the case of jobbers' drills, from the cutting point to the neck, but is necked on the Wilt automatic at the same time that it is pointed and cut off. The cylindrical surface is then soft-ground and the drill pointed. It is then electrically welded to the shank, the taper shanks being made on automatic screw machines from low-carbon steel. It has been found possible to weld the shank to the drill with a welding alignment accurate to 0.002 inch. After welding, the drill is hardened, tempered, straightened, etc., just as in the case of the jobbers' drill. While the principal changes effected by this process have been referred to, the Wilt automatic machine results in other changes in handling and inspection, which will be considered later.

Brief History of Development of Process

The Wilt process has been developed by A. D. Wilt, Jr., during a period of about ten years, although he began to work upon the first idea of making twist drills in some kind of automatic machine as early as 1905. In fact, the actual cause of the development goes back still further. After having graduated from the Harvard Engineering School in 1903, Mr. Wilt came to the National Cash Register Co., at Dayton, Ohio, and in the course of his work with this company found occasion to study the manufacture of twist drills, because of the great number of drills that were used by this company. From this time on he began maturing the idea, having gained experience and knowledge in automatic machinery during his employment as production engineer of the Burroughs Adding Machine Co., of Detroit, Mich., and later in the same capacity for the Standard Screw Co., which probably operates more automatic metal-cutting machinery than any other company in the United States in its five factories located in Detroit, Mich., Chicago, Ill., Hartford, Conn., Worcester, Mass., and Elyria, Ohio. In 1907, Mr. Wilt organized the Schweppe & Wilt Mfg. Co., Detroit, Mich., maker of automobile parts, of which company he has been president ever since and in the plant of which the new twist drill machines have been developed. In 1913, he organized a Canadian company for the manufacture of twist drills. Being engaged in twist drill manufacture, an opportunity presented itself for trying out in practice the efficiency of the machines designed.

In the development of the automatic twist drill machines to be described, E. J. Lees, of the Lees-Bradner Co., Cleveland, Ohio, gave valuable assistance by carrying out the design of the first machine, and later C. H. Whipple, of Detroit, Mich., designed and developed the two sizes of machines for the smaller sized drills—in fact, in the latest machine he has solved the problem of handling efficiently the hot-rolled bars as they come from the mill.

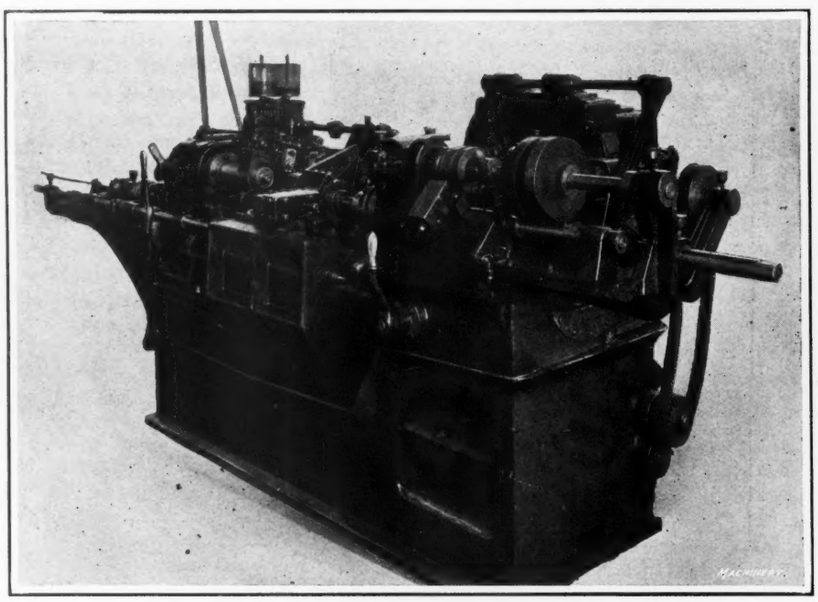


Fig. 1. Automatic Single-spindle Multiple Cutter-head Twist Drill Machine

Types and Sizes of Machines

For a complete line of automatic twist drill machines, except for the extremely large sizes of drills, three sizes are necessary, two of which have already been built. The largest machine, known as Type A, makes drills from ½ to 1¼ inch in diameter. This machine is provided with six collets or blank-carriers in the turret, one for cutting off and pointing, three for the successive rough-grooving cuts, one for finish-grooving, and one for milling the clearance. The next smaller machine makes drills from ⅛ to ½ inch in diameter. This machine is provided with four operating positions—one for cutting off and pointing, one for rough-grooving, one for finish-grooving, and one for milling the clearance. This machine is known as Type C. The smallest machine, known as Type D, makes drills ¼ inch in diameter and smaller and has four operating positions, the same as the Type C machine. Hot-rolled bars are customarily used for all sizes above 5/16 inch in diameter; for the smaller sizes, drill rod in long lengths is employed.

General Features of Machine and its Action

The mechanism of the automatic twist drill machine may be divided into two general groups: first, the means of severing the drill blanks from the bar of stock and of presenting them to the different cutting tools successively—which includes the means of advancing, withdrawing, and indexing the blank-carrier—and, second, mechanism for driving the different cutting tools and for controlling the action of these tools as required by the form of the product and the operation of the machine itself. While this machine is multiple in the sense that it has several cutter-heads which operate simultaneously on different blanks, all the blanks are cut from a bar of stock which is fed through a single spindle equipped with a suitable stock-feeding mechanism. In this respect the machine is radically different from a multiple-spindle automatic screw machine which operates on several bars of stock at the same time.

When the automatic twist drill machine is in operation, the bar of stock, after being fed out to the required length, is cut off by a V-shaped tool, which forms a conical-shaped end or male center on the inner end of the blank being severed and also on the outer end of the next successive blank. While the cutting-off and pointing tool is at work, the blank-carrier is advancing to receive the blank. The blank-carrier has several spindles equipped with collet chucks for holding the blanks. These spindles are equally spaced and are equidistant from the main shaft of the turret-carrier. The different cutting tools required are located opposite the blank-holding spindles. As soon as a blank is cut off, it is gripped by whichever spindle happens to be opposite the stock-feeding spindle. The blank-carrier then moves backward and indexes or rotates far enough to locate the blank that has just been cut off directly opposite the first tool-head, carrying two opposed roughing cutters, which take a roughing cut through the groove as the blank feeds forward. If the drill is larger than 1/2 inch and the work is being done on a Type A machine, the groove is first milled as indicated by the dotted line *a* of sketch *A*, Fig. 5. The next indexing movement locates the blank opposite

the second set of rough-grooving cutters, which take cut *b*, and then it is indexed around to the third set of roughing cutters (cut *c*), and finally to the finishing cutters. The next and last operation on this machine is the milling of the clearance, which is done by means of end-mills, as indicated by sketch *B*, Fig. 5. The blank is now ejected from the chuck of the blank-carrier spindle, and another indexing movement locates this particular chuck opposite the stock-feeding spindle and in position for receiving another blank. It is evident, therefore, that as soon as the blank-carrier has made the first complete revolution after starting the machine, each spindle contains a blank, and all these blanks are operated upon whenever the blank-carrier advances; consequently, one blank is finished, so far as this machine is concerned, every time the blank-carrier indexes, the operation in this respect being similar to that of a multiple-spindle automatic screw machine.

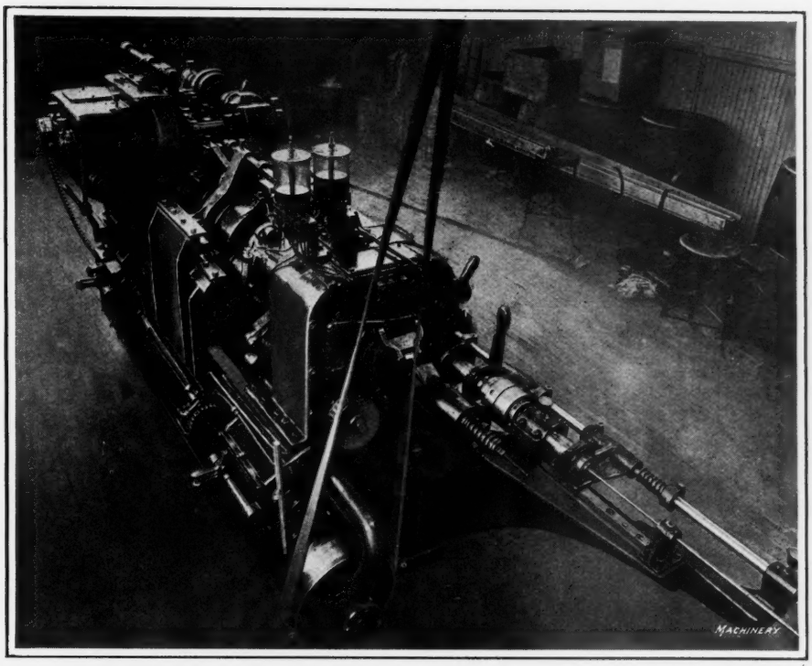


Fig. 2. View showing Rear Side and Stock-feeding End of Automatic Twist Drill Machine

The collet chuck of the stock-feeding spindle is opened and closed in the usual manner by the action of a sliding collar having a tapering section which operates bellcrank levers and a tube connecting with the chuck. The chucks of the carrier spindles are also of the collet type, and in the center of each of these spindles there is a rod which, at the proper time, moves forward relative to the spindle and ejects the drill after it has been grooved and the clearance milled. Before the blank is ejected, the sleeve of the chuck-closing mechanism is engaged by two spring-actuated arms which open the chuck and release the finished blank.

In making a twist drill, the milling of the grooves is the longest operation and the one requiring the removal of the most metal; consequently, the machine designed for medium- and large-sized drills has three sets of roughing cutters, as mentioned, so that the work of milling the groove to the full depth is distributed. The result is that the rate of production is not controlled and reduced by the groove-milling operation, and the output of the machine is much higher than it would be otherwise.

Variable Movements of Blank-carrier or Work-holding Turret

When the blank-carrier advances toward the stock-feeding spindle and the cutting tools, it moves quite rapidly up to the cutting position, and then at a reduced speed while the cutters are milling the grooves and the clearance. As the grooves are helical, it is necessary to rotate the blanks as they advance in order to generate a helix or twist of the required pitch. The mechanism for obtaining this rotary movement will be described later. After the tools are withdrawn to clear the drill blanks, the carrier returns rapidly to the starting point and the indexing movement occurs. The mechanism for transmitting and controlling these motions will now be described.

The forward and backward motions are derived from the mechanism shown partly in diagrammatical form in Fig. 8. The blank-carrier *A* is mounted upon shaft *B*, on which it is free to rotate. This shaft and the blank-carrier are given a lengthwise traversing movement when the machine is in operation. A sleeve *C* having a screw thread on it is attached to the carrier and engages a nut *D*, which is revolved by means of worm-gearing for traversing the carrier. All the motions of this machine are derived from the main shaft *E*, which transmits motion to the tool-heads of the machine, as well as to the blank-carrier. The transmission in each case is through a gear-box, there being one of these gear-boxes to provide speed changes for the cutters and another to vary the speed of the blank-carrier mechanism. (These gear-boxes and the levers for controlling the speed changes may be seen near the base of the machine, Fig. 2.) The silent chain drive, by means of which motion is transmitted from one gear-box to the mechanism for operating the blank-carrier, may be seen at the end of the machine in Fig. 1. The shaft which is driven by the silent chain drives worm-shaft *F* (Fig. 8) through different combinations of gearing, which are automatically engaged and disengaged in order to vary the forward and backward traversing movements. There are two driven shafts *G* and *H*. A pinion on shaft *G* meshes with a loose gear H_1, and another pinion on shaft *H* meshes with a loose gear G_1, the pinions in each case being attached to their respective shafts. Shaft *H* is also connected by gears at *I* with worm-shaft *F*. The automatic

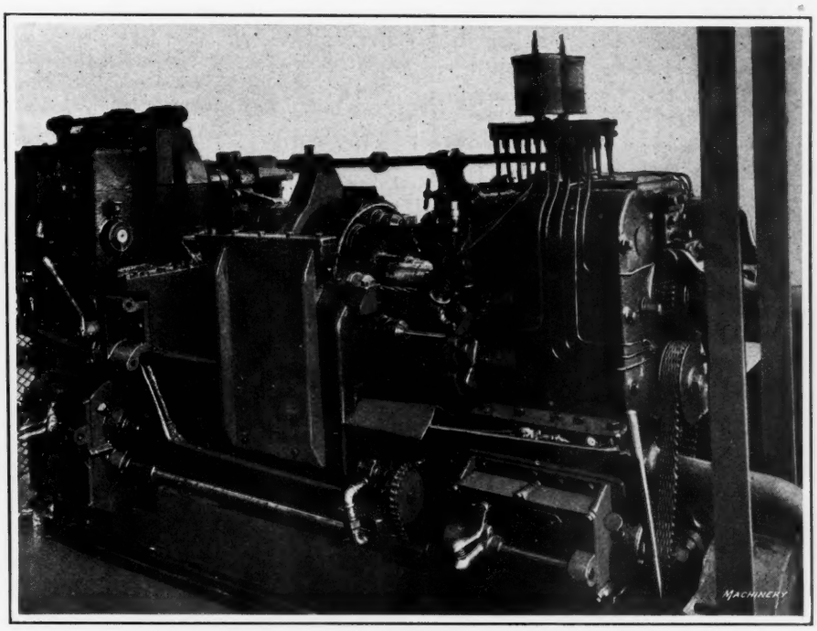


Fig. 3. Another Rear View of Automatic Twist Drill Machine

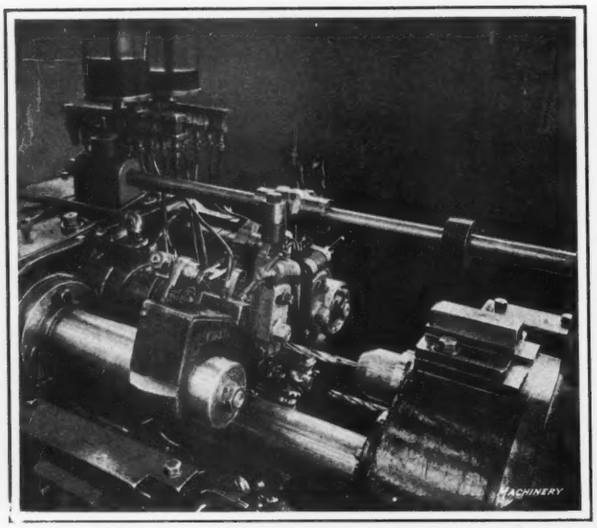


Fig. 4. Detailed View of Cutter-heads as seen from Front

control of the speed changes is effected by two clutches J and K, which, in turn, are operated by cams and other controlling mechanisms to be described. The cams located at L and M, and the levers and rods extending from the clutches to the cam, are clearly shown in the illustration.

After the indexing movement, cam L has turned to such a position that clutch J is shifted into engagement with gear G_1 for obtaining the fast forward movement of the blank-carrier, motion being transmitted from shaft G through gear G_1 to shaft H and then back through gears I to shaft F and the worm-gearing operating nut D. Just before the cutting tools begin to operate upon the blanks, the shaft carrying cams L and M again makes a partial turn (one-quarter revolution), and this causes clutch J to be disengaged from gear G_1, while at the same time clutch K, through the movement of cam M, is engaged with gear H_1. This imparts to the blank-carrier the slow forward movement which is required for milling the grooves and clearance. As soon as the blank-carrier has advanced far enough, another quarter revolution of cam M dis-

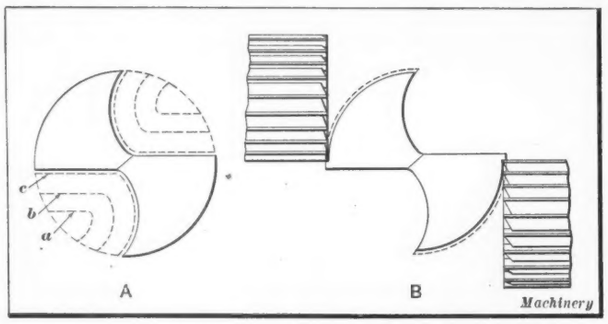


Fig. 5. Diagrams illustrating Methods of milling Grooves and Clearance or Relief

engages clutch K from gear H_1 and throws it into engagement with gear O, which gives the blank-carrier a quick reversing or backward movement.

Controlling and Indexing Mechanism of Blank-carrier

The forward and backward motions of the blank-carrier, in conjunction with the indexing movement, are utilized to control the different traversing speeds previously referred to, by means of a mechanism that allows the shaft carrying cams L and M to revolve one-quarter revolution each time a speed change is required. This camshaft is connected by a slip clutch and gearing with one member of clutch P. This half of the clutch is in the form of a loose sleeve, and it is connected through spiral gears with shaft G. This loose sleeve revolves continuously, but shaft Q, which serves to index the blank-carrier, is rotated intermittently when, at the extreme backward movement of the blank-carrier, clutch P is engaged. Shaft Q carries a pinion which meshes with the large gear on the blank-carrier A, and in the case of the Type A machine, this carrier revolves one-sixth revolution for each complete turn of shaft Q. Incidentally, the pinion on shaft Q is shrouded or has flanges, and it is traversed with the blank-carrier.

The shaft Q is normally prevented from rotating by means of a stop R, Fig. 7, engaging a notch R_1 formed on a wheel carried by shaft Q. This shaft operates a slide S (see also Fig. 8) by means of a sleeve S_1. Slide S carries a rocking arm T, at one end of which there is a spring-actuated pivoted dog T_1, which may be engaged by the beveled side of a shoulder on plunger U. On the forward movement of a blank-carrier and shaft Q, a spring surrounding plunger U is compressed, and the plunger is cocked or retained by the pivoted spring pawl U_1. On the backward or return movement, this pawl,

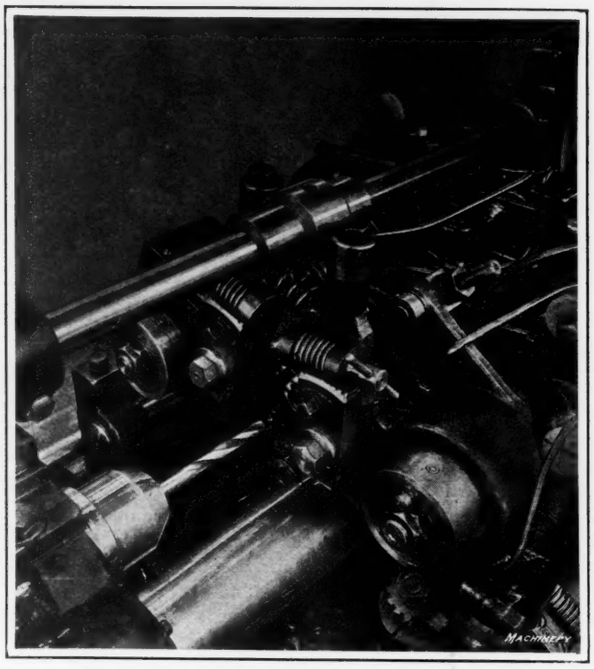


Fig. 6. Detailed View of Cutter-heads as seen from Rear

when near the limit of its travel, encounters a fixed stop, and is thereby released from the shoulder of plunger U, which, under the action of the spring, pushes back and rides over dog T_1. This rocks the pivoted arm T and releases the stop R from the notch R_1 in the disk on shaft Q; consequently, shaft Q is permitted to make a complete revolution, thus indexing the blank-carrier. Just how this indexing movement affects the mechanism for controlling the traversing speed of the blank-carrier will now be described.

To begin with, there is an index wheel V, Fig. 8, on the shaft carrying the controlling cams L and M. This index wheel has four notches which may be engaged by a pawl mounted on shaft V_1, which is free to oscillate. This pawl is provided with an extension that engages successively with cam W and the beveled disks X and X_1. This cam and the

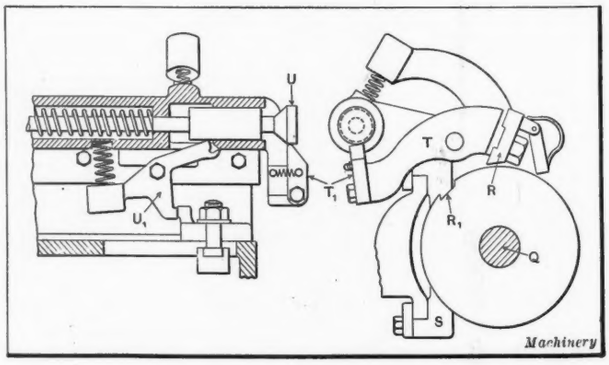


Fig. 7. Locking Device which forms Part of Indexing Mechanism

two disks are fixed to shaft *Q*. At the right-hand end of shaft V_1 there is a lever arm which, on the backward movement of shaft *Q*, engages beveled disk *Y*. When shaft *Q* turns through a complete revolution for indexing, the cam *W* releases the pawl from index wheel *V*, thus permitting the latter to make one-quarter turn, the movement being arrested by the engagement of the pawl with the next succeeding notch. The camshaft tends to rotate constantly, since it is connected by a slip clutch and gearing, as previously mentioned, with the sleeve of clutch *P*, which rotates constantly. This first movement of index wheel *V* is for the fast forward speed.

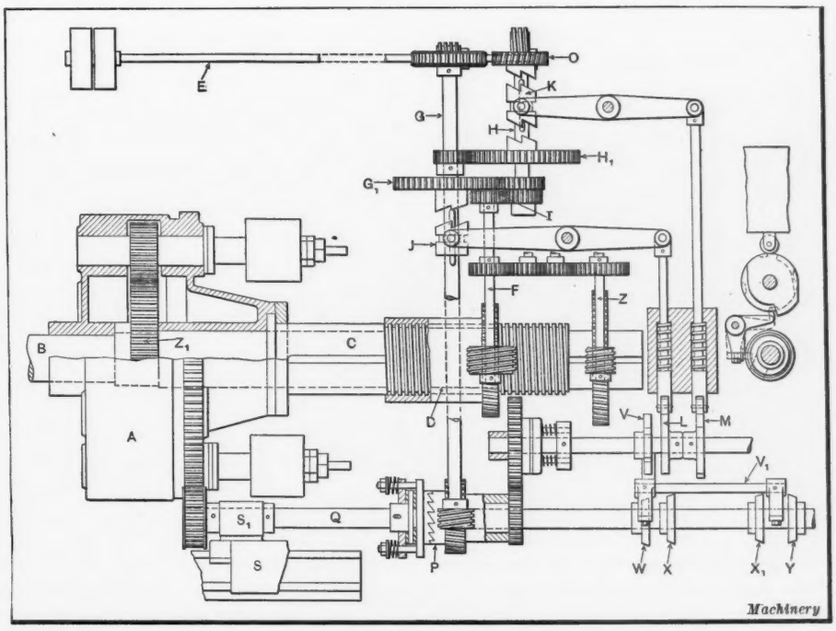


Fig. 8. General Arrangement of Mechanism for controlling Traversing and Indexing Movements of Blank-carrier or Work-holding Turret

As the blank-carrier and shaft *Q* continue to move forward, the beveled disk *X* again releases the pawl and the index wheel, which makes another quarter revolution, thus reducing the traversing movement for the cutting operation. The cutting tools are at work while the pawl is passing from disk *X* to X_1, and when the latter is encountered, index wheel *V* makes a third quarter turn, thus reversing the motion of the blank-carrier. On the return movement, the bevel disk *Y* again lifts the pawl and releases the index wheel, which makes a quarter turn and shifts clutch *K* to the intermediate or neutral position.

As it is essential to locate the blank-carrier accurately relative to the tools after each indexing movement, a positive method of holding and guiding it has been provided. Rectangular-shaped blocks are attached to the carrier, one of which engages a guide attached to the bed of the machine each time the blank-carrier advances. One of these blocks may be seen at the top of the blank-carrier in Fig. 4, and the guide at the front of the machine is clearly shown in Figs. 2 and 3.

Rotation of Blank-carrier Spindles for Generating Helical Grooves

The slow rotary speed of the blank-carrier spindles which is necessary for generating the helical grooves in the drills is derived from the mechanism illustrated in Fig. 8. The spindle *F*, which drives nut *D* through worm-gearing, also transmits motion to worm-shaft *Z* through change-gears selected according to the lead of helix required. The worm on shaft *Z* drives a worm-wheel on a sleeve keyed to the main shaft *B* (see also Fig. 9). In this way, a slow rotary motion is imparted to shaft *B*, and through it, by means of gear Z_1, to the blank-carrier spindles, which have pinions meshing with gear Z_1. This slow rotary movement, in conjunction with the advancing motion of the blanks, causes the tools to generate helical grooves. This machine mills a constant angle drill which the designers consider superior to an increased twist drill. While the machine is not arranged to produce drills having an increased twist, it may be adapted to such work by making a simple change. This change involves connecting a pin with a groove cut in shaft *B*, so that the forward traversing movement is varied independently of motion derived from the gearing referred to. For average purposes, a lead equal to one turn in a length equal to six diameters is considered the best for high-speed steel drills, and a lead of one turn in a length of seven and one-half diameters for carbon steel drills. The width of the groove may be slightly wider than the land or exactly equal to the land, which is also considered good practice.

Withdrawal of Grooving Cutters

The web of the drills made in this machine is of uniform thickness for about one-third of the length of the groove, and then the thickness is gradually increased for the remaining two-thirds of the length, so that at the upper end of the groove it is equal to about one and one-half times the thickness at the point. One of the most interesting features of this

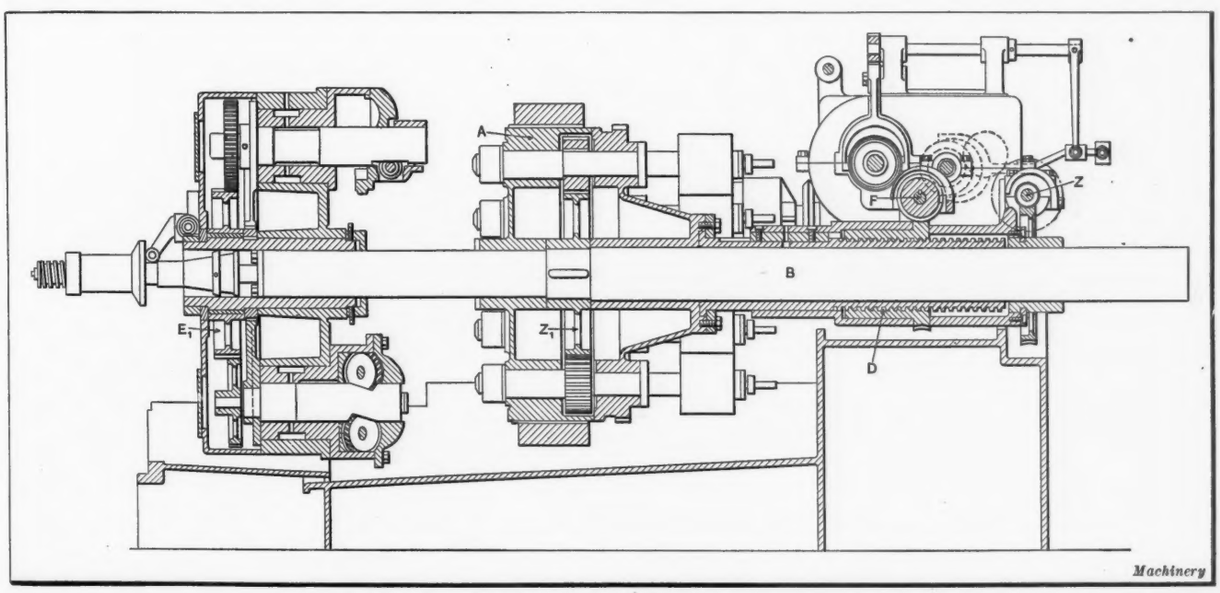


Fig. 9. Vertical Section showing Relative Positions of Blank-carrier and Cutter-heads

machine is the mechanism for controlling the action of the grooving cutters. The method of driving these cutters, as well as those for milling the clearance, is illustrated in Figs. 10 and 11. The main shaft E transmits motion to a central gear E_1, which, in turn, meshes with the pinions surrounding it, as the illustration shows. (This illustration does not represent the exact construction, as motion from main shaft E on the machine, as actually built, is transmitted through a gearbox and a silent chain drive.) The shafts carrying the pinions drive the cutters through spiral gearing, as shown in Fig. 11.

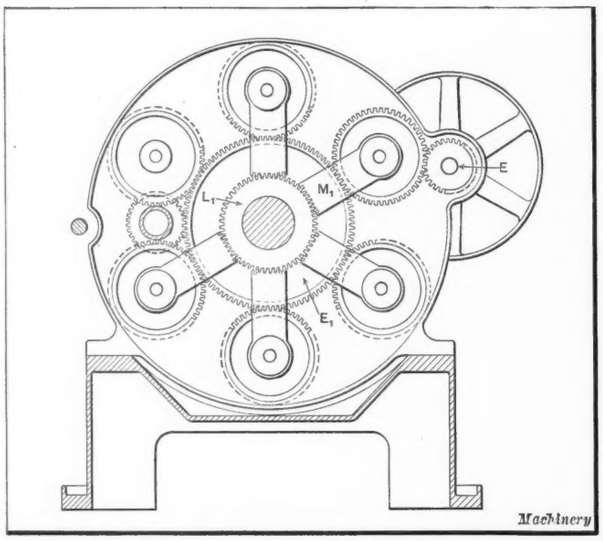


Fig. 10. Arrangement of Gearing for driving Cutter-heads and withdrawing Cutters

As the blank-carrier advances, it is necessary for the grooving cutters to move outward gradually, in order to increase the thickness of the web. Then, when the cuts are completed, both the grooving and clearance cutters must withdraw to clear the work and prevent marring it while the blank-carrier moves backward. The longitudinal movement of shaft B is utilized for shifting the position of the toolholders. At the end of this shaft, there is an inclined member J_1; see Fig. 11, which illustrates the principle of operation, but not the exact construction. This inclined or tapering member engages with a roller at the end of lever K_1, which serves to operate a worm attached to a sleeve carrying gear L_1 (see also Fig. 10). This gear, in turn, meshes with the segmental gears M_1, which are fixed to the heads carrying the cutting tools. With this arrangement, the forward movement of the blank-carrier and shaft B causes lever K_1 to swing upward, thus turning slightly gear L_1, segmental gears M_1, and the pivoted members carrying the cutters. The result is that the cutters are swung outward from the center of the work. The amount of this outward movement depends upon the inclination of the part J_1.

When the end of the cut is reached, lever K_1 encounters a more abrupt projection and is moved outward quickly, thus separating the cutters far enough to clear the blanks when the blank-carrier returns to the starting position. This is an important detail in the design of the machine and it prevents the tools from marring the work as the latter is withdrawn. Just before shaft B reaches the end of its backward movement, the conical-shaped flange O_1 engages lever K_1 and forces it down, thus returning the cutters to the position required for the next milling operation. This flange is backed up by a stout spiral spring to take up the shock. The mechanism on the machine illustrated in Fig. 1, which controls the withdrawal of the cutters, is similar in principle to that just described, but instead of a conical sleeve J_1, Fig. 11, the action of the worm-lever is derived from an inclined guide which can be readily adjusted.

Arrangement of Tool-heads

The cutter-spindles are mounted in heads which have a swiveling movement either for withdrawing the cutters as just described, or for adjusting them relative to the work, in order to vary the depth of the cut. As Fig. 11 shows, each cutter of a pair is carried by a different head, and as these heads are adjustable relative to the sleeves upon which they are mounted, the position of the tools for varying the depth of the cut may easily be regulated. The fine adjustment of the grooving cutters is effected by the screws N_1 in this particular design. (The machine illustrated in Figs. 1 to 4, inclusive,

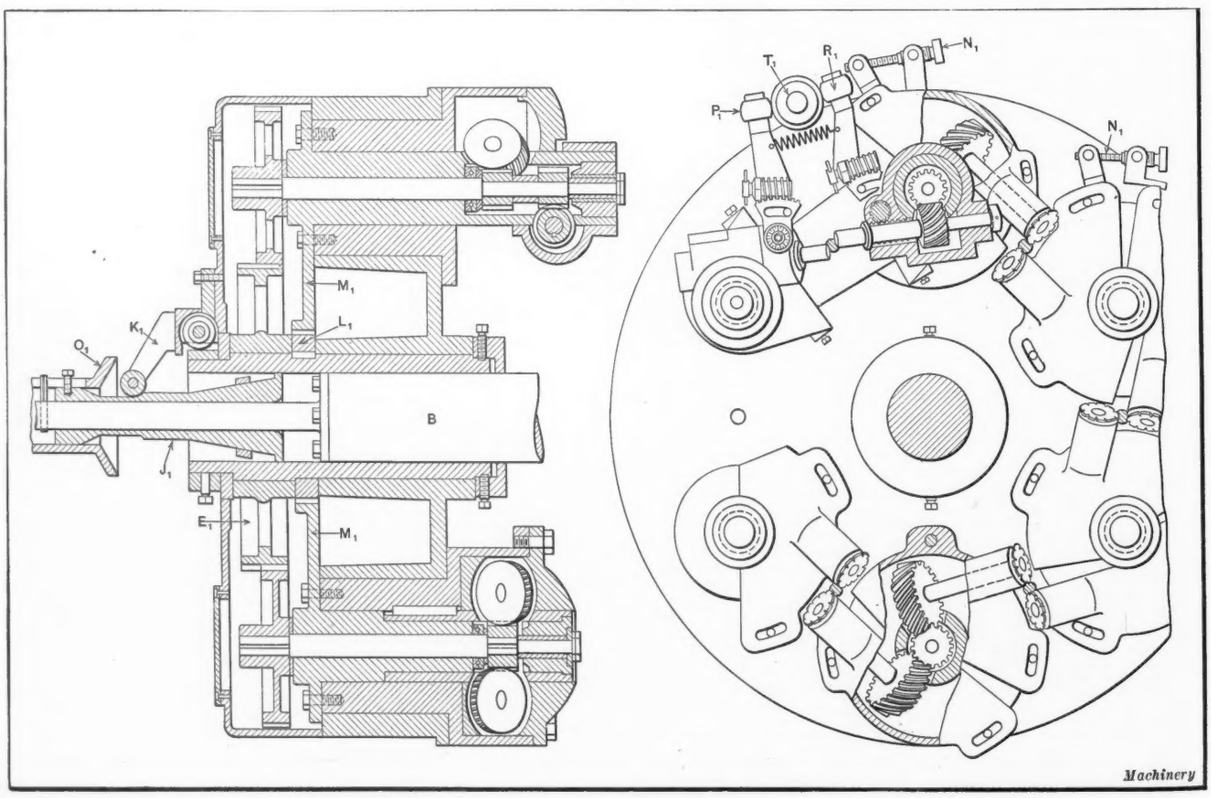


Fig. 11. Mechanism for driving Cutters and regulating their Position relative to Work

has the same general type of adjustment, but the arrangement is different. Instead of using a screw, the position of the cutter-head relative to the sleeve about which it swivels is varied by a worm engaging with teeth formed at the end of the cutter-head extension.)

A special feature of the machine is that the pilots for guiding the drills made from the hot-rolled bar are made 0.015 inch over size to allow for the variations in the diameter of the bar. This is permissible for two reasons: In the first place, oil is fed through the bushings from the inside on high pressure, which provides a film of oil under pressure all around the bar as it enters the bushing and steadies it; in the second place, the roughing cuts are divided on larger drills, where the cuts would be heavy, so that there is not the excessive vibration that there would be in an ordinary drill fluting machine. One cutter milling on each side also tends to steady the drill, making the support in the bushing of less importance. Of course, were the full depth of the groove on a large-sized drill milled at once, the vibration set up would make it impossible to support the rod in a bushing with so much clearance.

Withdrawal of Clearance Cutters

The end-mills which form the relief or clearance are the last to operate upon the blanks. These cutters, of course, remain the same distance apart while at work, but it is essential to separate them at the end of the cut in order to clear the blank, the same as with the grooving cutters. A special mechanism is provided for withdrawing the clearance cutters. This is illustrated clearly in Fig. 4. The same general type of mechanism is also shown in Fig. 11. As the latter illustration shows, the spindles may be moved axially by a rack and pinion when the levers P_1 and R_1 are separated by a cam sleeve T_1. These levers are held in contact with the sleeve by a spring as shown, and the cam sleeve has an enlarged portion (see also Fig. 4) with which the levers are engaged for withdrawing the cutters from the working position. This cam sleeve is mounted upon a shaft that is free to move lengthwise in its bearings. One bearing is on the cutter-head and the other on the blank-carrier. The shaft has attached to it two collars, there being one on each side of the blank-carrier bearing. These collars are alternately engaged by the blank-carrier, as it advances and returns, and the distance between them is such that the cam sleeve previously referred to is shifted at the right time. The cutters have an independent adjustment for regulating the depth of the cut which is practically the same as that described for the grooving cutters. The graduated screws or worms for making this adjustment are clearly shown in Fig. 4.

General Features of Design

The features which are most apparent upon an inspection of the automatic twist drill machine are its rigidity, adjustability, rapidity of action, and capacity for accurately duplicating work for which it is adapted. This machine is unusual in its general design on account of the absence of flat slides and the elimination of special cams for controlling the various movements. There is not a flat slide on the entire machine of the kind requiring gibs to compensate for wear, unless the guideway for holding the blank-carrier in alignment as it moves forward can be classified as a flat slide. All sliding surfaces are cylindrical, which the designers consider a commendable feature. If the action of the machine must be varied to adapt it for work of different diameters or length, this merely involves making certain adjustments, and it is not necessary to equip the machine with a different set of special cams. This is due to the fact that variations in the cycle of operations are obtained simply by adjusting certain parts of the controlling mechanism and possibly changing the gears which control the lead of the helical grooves. In brief, the design is self-contained or independent, which is regarded as a valuable principle in a machine of this type or in other classes of automatic machinery, the action of which must be modified to meet different operating requirements.

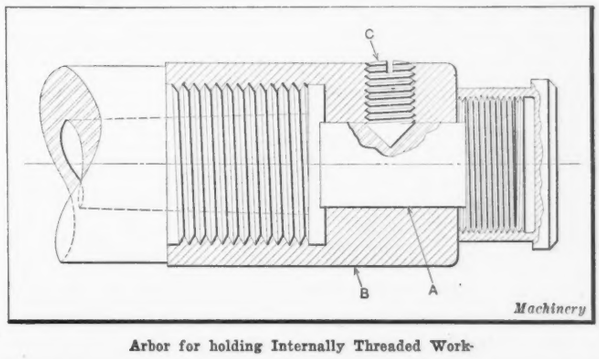
Under ordinary conditions, one operator and two helpers should be able to take care of a battery of ten machines. This not only greatly reduces the direct labor cost by performing automatically the various separate machining operations required by the other methods, but it also effects great savings in overhead. For example, fewer foremen are needed, because the machine combines a number of different operations usually done in a number of different departments by the old method. A number of handlings are eliminated. On making the 1/2-inch jobbers' drill, for example, the machine saves at least six truckings or handlings and two inspections, and the process saves overhead in other ways. It requires about one-fifth the space required by a similar number of machines to produce a given number of drills per hour by the old methods, with a consequent saving of heat and light, as well as interest on buildings, transmission equipment, etc.

The machinery cost by the Wilt method seems to be about the same as that by the old method, that is, the machinery investment necessary to produce a given size of drill at the rate of one per minute. While it has been impossible to get accurate figures on cutter savings, there is undoubtedly a saving in cutters by virtue of the method of taking roughing and finishing cuts on the same groove. The end-mill method of clearing used is found to be most economical. Also when one milling cutter removes all the material from a groove, it cannot be run as fast, because of the necessity of having the single milling cutter preserve the contour of the groove, as well as produce a smooth finish. As soon as the cutter becomes worn down the groove loses its contour. As the finishing cutters take such a light cut, there is no trouble from this source. In fact, by taking this light finishing cut, the operations of polishing and grinding grooves by the old method, which are direct labor costs in most factories, become overhead costs by the Wilt process. A very small percentage of drills made by the Wilt process have to have the grooves polished or ground, a good finish being secured by the sand-blasting operation only. It is estimated that on carbon steel drills there is a total saving in the manufacturing costs of at least 30 per cent over the cost of making drills by the methods generally employed.

* * *

STUD ARBOR

The purpose of this arbor is to hold an internally threaded piece of work for finish on the outside or on the end. In this class of work, the pressure of the tool would normally tighten the thread so that it would be impossible to remove the work without unduly marring the finish. This arbor overcomes this objection as follows: The member A has a threaded portion on the end, and it protrudes from body B,



Arbor for holding Internally Threaded Work

fitting it snugly. The body B is threaded on the rear end to fit the spindle of a regular turret lathe. Member A is held securely from longitudinal movement by screw C which has a conical point, fitting in a similar shape in the member A. When the work is placed on the end of the threaded arbor A, the screw C is seated fully in the countersunk portion of the arbor. At the end of the operation, the work has become tightened upon the arbor A, and by relieving the screw C the arbor moves forward a slight amount making it possible to remove the work with the fingers. V. B.

* * *

A California court of appeals has decided that a foreman who was assaulted by a man he had dismissed was injured in the discharge of his duties and therefore entitled to compensation.

FUSION WELDING FALLACIES[1]—1

SOME COMMON BELIEFS AND WHY THEY ARE UNSOUND

BY S. W. MILLER[2]

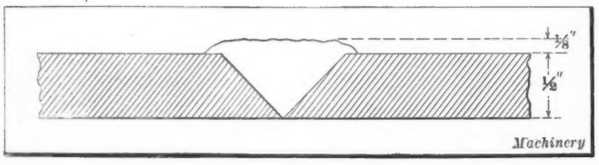


Fig. 1. Reinforced Weld

WITHIN the past two decades, fusion welding processes have been developed until they are now used both in the manufacture of articles, the parts of which would otherwise be riveted or joined by other means, and in repair work. In both fields, they have proved of exceptional value, and in many cases have revolutionized past manufacturing methods and made it possible to place on the market cheaper and better articles than was possible by the processes displaced; but fusion welding processes are not simple, and many fallacious ideas concerning them are prevalent. The more important of these will be treated in this series of articles; those that will be treated in the present installment are as follows: The belief that a reinforced weld is stronger than a weld of the same thickness as the sheet; that reinforcing a weld is as good as welding through a piece; that high tensile strength in a weld is of great importance; that wrought iron is the best welding material; that any wire is good enough for the added material; and that the addition of small quantities of metal at a time is good practice.

Reinforcing does not Necessarily Strengthen a Weld

Frequently a welder is advised to reinforce a weld; that is, to increase the thickness of the piece at and in the vicinity of the weld, as shown in Fig. 1, on the theory that the greater the amount of metal, the stronger is the piece; but this is not always true. Particularly is it not true when plates are welded from one side, as in the case of tanks, etc.; in fact, reinforcing then weakens the structure. This weakness is due to two conditions: First, the thickening of the weld concentrates the stresses at the junction of the thick and thin parts, which is likely to result in a detail fracture, even in uniform material; this is the same as having sharp corners in shafts, which frequently break from this cause. Second, the center lines of the reinforced weld and the sheet are not the same; therefore, a bending stress is introduced in addition to the tensile stress. This condition is called "eccentric loading," and the maximum fiber stress on the section may then be found by the formula:

$$S = p\left(1 + \frac{6E}{A}\right)$$

in which S = maximum fiber stress in section;

p = mean fiber stress in section, or $\frac{P}{A}$;

E = eccentricity or distance from center of section;

A = width of section;

P = total pressure on any section of a bearing of uniform thickness.

Assuming that the sheets shown in Fig. 1 are straight and that the piece is subjected to an average stress p of 12,000 pounds per square inch, based on the thickness of the weld, P will be 6000 pounds; as shown, E is 1/16 inch, and A, 0.5 inch. Then, by the formula, the maximum fiber stress will be:

$$S = 12{,}000 \times \left(1 + \frac{6 \times 1/16}{0.5}\right) = 12{,}000 \times 1\tfrac{3}{4} = 21{,}000 \text{ pounds}$$

or 1¾ times the average stress over the section of the weld. But, based on the thickness of the sheet, the piece would be subjected to a stress p of 15,000 pounds per square inch. Then P will be 7500 pounds; E is 1/16 inch; and A, 0.5 inch. Then the maximum fiber stress will be:

$$S = 15{,}000 \times \left(1 + \frac{6 \times 1/16}{0.5}\right) = 15{,}000 \times 1\tfrac{3}{4} = 26{,}250 \text{ pounds}$$

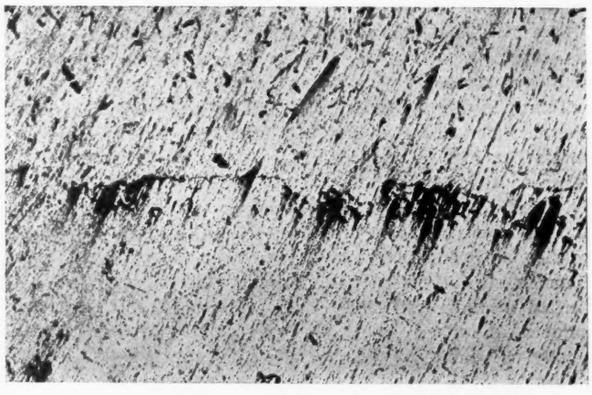


Fig. 3. Laps and Dirt along Edge of Vee; magnified 50 Times

In each case the maximum fiber stress will be too great for safety. This difference between the maximum and minimum stresses on opposite sides of the sheet causes the plate to bend toward the bottom of the vee, and, in the course of time, is very likely to result in fracture. The time necessary for this to occur may be short or long, depending on the eccentricity of the load and on the amount of the stress. Especial attention is called to the fact that a comparatively small eccentricity produces enormous fiber stresses, and it is possible for these stresses to be so great that the piece will break the first time the load is applied. Any results obtained from tensile test pieces made with reinforced welds are erroneous and misleading. All published tests the writer recalls were made on test pieces that were not machined, which doubtless contributed largely to the discordant results obtained. There are no published results of weld tests that are consistent, as far as the writer knows.

Somewhat along the same lines is the statement that reinforcing a weld is equivalent to welding through the piece, which was made to the writer some time ago by the foreman of welders in an important tank shop. It is evident that where

[1] For further information on fusion welding, see "Strength of Oxy-acetylene Welds," in the June, 1916, number of MACHINERY; "Metal Cutting with Oxy-acetylene Gas," April, 1916, and the articles there referred to; "Electric Seam Welding," January, 1917, and the articles there referred to.

[2] Address: Rochester Welding Works, Rochester, N. Y.

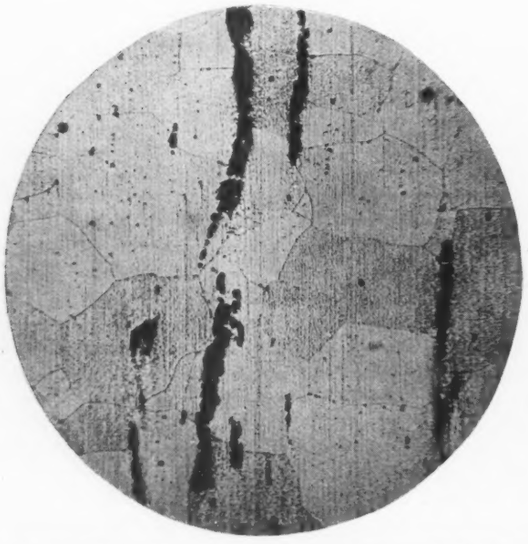


Fig. 2. Wrought-iron Wire showing Streaks of Slag; magnified 200 Times

the weld is not made entirely through the vee, the eccentricity and the fiber stress are greatly increased, thus weakening the structure.

High Tensile Strength in a Weld is Seldom of Great Importance

Most welders, in speaking of the quality of their welds, lay great stress on the tensile strength. As a matter of fact, high tensile strength is of much less importance than other characteristics. No important engineering structure that the writer can think of at the present moment is subjected, in any of its parts, to an unvarying tensile stress. The stress always varies from zero, or some amount, to a maximum, or from a maximum in one direction to a maximum in the other; in addition, these changes are usually accompanied by shock. To provide for these variations from a steady stress, it is customary to lower the permissible fiber stress, especially in the last case. For instance, a boiler or pressure vessel is never free from changes in pressure, and so the proper reduction in stress must be made.

A weld is nothing more than a casting that has not been heat-treated; and while it has enough tensile strength, it is brittle and has low resistance to shock, vibration, and changes in stress. It is far more important to produce a weld without these bad qualities than to strive for high tensile strength, as the strength is always sufficient if the weld is no thicker than the sheet. In fact, an unannealed weld resembles, in ductility, a piece of cast iron. This is very noticeable in pulling test welds in a tensile testing machine, as, when not annealed, it is difficult to get their elastic limit, it being frequently so close to the ultimate strength that the piece breaks before it is really certain that the drop of the beam has occurred. It is, therefore, evident that physical properties heretofore generally neglected must be obtained in welds even at the sacrifice of some tensile strength.

Wrought Iron is not Necessarily the Best Welding Material

The statement is commonly made that wrought-iron wire is the best material for welding steel; in fact, in 1915, the writer made the following statement: "It is generally claimed that wrought-iron wire is the best for this purpose and that the imported wire is better than the domestic. . . . It is, however, somewhat of a question whether material with a small percentage of carbon, say, 0.1 per cent or, perhaps, as low as 0.05 per cent, would not give just as good results, provided the impurities, such as sulphur and phosphorus, were kept to as low a point as is the case in wrought iron. There are other matters in connection with this subject that have never been investigated, as far as the author knows, and inasmuch as their investigation requires great accuracy and considerable time and expense, the lack of information is not to be wondered at. It is a fact, however, that the use of any pure iron wire gives good results and, until the matter is more carefully investigated, one is safe in using that material." Wrought iron of the purest kinds was probably the best material available at one time, and it was much better several years ago than it is now. Also, as the demand for welding wire was small, it did not pay to make special materials for this purpose. However, wrought iron made by the puddling process contains slag which is likely to get mixed in the weld and weaken it. This may be seen in Fig. 2, where a piece of wire is shown magnified 200 times; also in Fig. 3, which shows the laps and dirt along the edges of a vee that has been magnified 50 times. There is no use in putting into a weld foreign matter that must at once be removed, but which can be done only with considerable trouble on the part of the welder. Low-carbon steel wire is free from slag, as shown in Fig. 4, and is, therefore, superior to a product that contains it. Still, care must be taken to get wire quite free from sulphur and phosphorus, either of which may cause trouble in the weld; and as ordinary wire is likely to contain these in quantity, it should be avoided.

Fig. 4. Low-carbon Steel Wire, magnified 200 Times, showing Absence of Slag

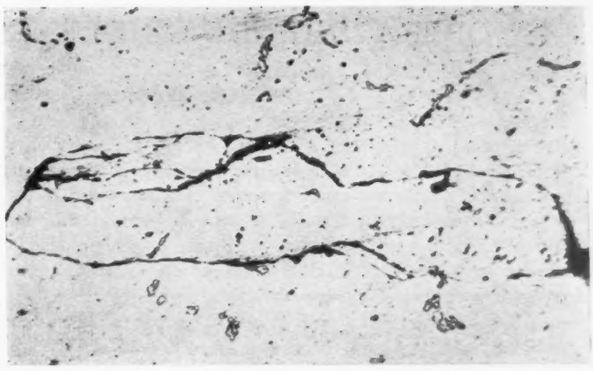


Fig. 5. Laps in Weld; magnified 430 Times

Adding Small Quantities of Metal at a Time is not Good Practice

A steel casting manufacturer does not pour his molds from a number of small ladles, but uses one large enough to pour the entire casting at one time. He also keeps the metal fluid, so that dirt and impurities can get to the risers, producing a clean casting. Making a weld in steel is the same as making a steel casting. Following the analogy, the more metal that can be kept in a molten condition at a time in a weld, the cleaner it will be. Adding small quantities tends to produce laps and cold-shuts and to include impurities in the weld; this is shown in Fig. 5, which illustrates a weld magnified 430 times. A clean weld is the foundation of successful welding; therefore, the addition of small quantities of wire at a time should be avoided.

* * *

NOVEL SCHEME FOR WRECKING OLD MASONRY

The expansive force of quicklime, according to the *Scientific American*, has been lately used effectively in breaking up brick masonry. It was necessary to remove three foundation piers, each 12 by 20 feet in area and 12 feet high, and similar piers supporting working engines on each side prevented blasting. As cutting and breaking up by hand was too slow and expensive, the new method was tried. Vertical holes three inches across and three feet deep were bored three feet apart in both directions and were filled to within six inches of the top with quicklime, fresh and well slaked. The holes over the wet lime being closed with well tamped brick-dust, cracks started in ten minutes, soon breaking the pier-tops into three-foot cubes, and making subsequent hand operations easy.

* * *

According to the Wisconsin Industrial Commission reports, during the last half of 1917, the industrial accidents in the state showed a reduction of 14 per cent as compared with the corresponding period in 1916. This decrease is attributed to the commission's safety and sanitation work.

OPERATING THE GRIDLEY AUTOMATIC TURRET LATHE—2

EXAMPLES OF CAMMING AND SETTING OF TOOLS

BY DOUGLAS T. HAMILTON[1]

IN the first installment of this article, published in the June number of MACHINERY, the general directions for setting up and operating the Gridley automatic turret lathe were given. The present installment will take up some specific examples of work done on the machine and will show the camming required and the tool set-up necessary.

Tooling Lay-out for Making Counterbored Bushing

The counterbored bushing illustrated in Fig. 17 has been selected to show the working relations of the forming slide to the turret-slide, when working at the same time; and also of the cutting-off and counterboring tools when working at the same time. This part is to be made from 2½-inch cold-rolled steel, and hence will be handled on a 3¼-inch machine. The operations required to complete this part are:

Position	Operation
First	Form and drill large hole
Second	Drill small hole
Third	Skip
Fourth	Combination ream and counterbore, and cut off

The procedure to follow in setting the various cams, dogs, tools, etc., to complete this part is given in the following; the method of selecting the cams has been fully explained in the preceding article.

Assuming that the proper spring chuck and feed-chuck have been put into place and all the tools and cams used for a previous job have been removed, proceed in the following manner to set the cams, dogs, etc., for producing the part shown: First, crank the machine by hand, and when roll *B* is on the high point of cam *D*, roll *G* should be on the high point of cam 587-B. This cam should be relieved, depending on the amount that the collet feeds forward in closing on the work. To return the stop, return cam 66-B should be set to allow clearance for roll *G* to pass between it and cam 587-B. When roll *G* is flush with the high point of the return cam, the indexing dog should be set to index the turret. Indexing should only be done when the machine is operating on the fast feed. Now revolve the turret to bring the first slide into position, and set cam 64-B against roll *G*. The slow-feed dog should be set at this time for safety sake when setting up the machine. Crank the machine forward until roll *G* is on the high point of cam 64-B and set the forming cam to the high point of roll *H*, allowing clearance for the roll; also set the fast-feed dog on the cam-operating drum. Set the forming slide return cam 482-B and tool-slide return cam 63-B, allowing clearance for the rolls. Now crank the machine forward until roll *G* is flush with the high point of return cam 63-B and set the dog for indexing the turret; revolve the turret to the second slide, stopping the machine at this point.

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Setting Drilling Cam

The next operation is drilling the small hole, which is to be performed from the second slide; cam 62-B is selected for this operation. Set this cam and the slow-feed dog and crank the machine forward until roll *G* is on the high point of the cam 62-B; then locate the fast-feed dog. Set return cam 63-B, allowing clearance for the roll to pass, and crank the machine forward until roll *G* is flush with the high point of the return cam; then set the indexing dog. Plug up the indexing slot in the third position and index to the fourth position.

Setting Cut-off and Counterboring Cams

We are now ready to set the cams for the cut-off tool and counterbore, which, as shown in Fig. 17, work at the same time. Crank the machine to the high point of the cut-off cam 499-B, which, with the return cam 483-B, should be set so as to return the cut-off tool clear of the spindle nose when roll *B* is on the high point of the chuck-opening cam *C*. Crank the machine backward to the high point of the cut-off cam and locate return cam 155-B, so as to return the tool-slide far enough to allow the piece to drop off the counterbore when it is cut off. Again crank the machine backward and set cam 62-B for the counterbore, allowing clearance for the roll; set the slow-feed dog at the low point of cam 62-B, where the counterbore starts to work. The fast-feed dog should be set at the high point of the cut-off cam 499-B, and the revolving dog should be set after the machine has been shifted to the fast feed. This completes the preliminary setting of the cams.

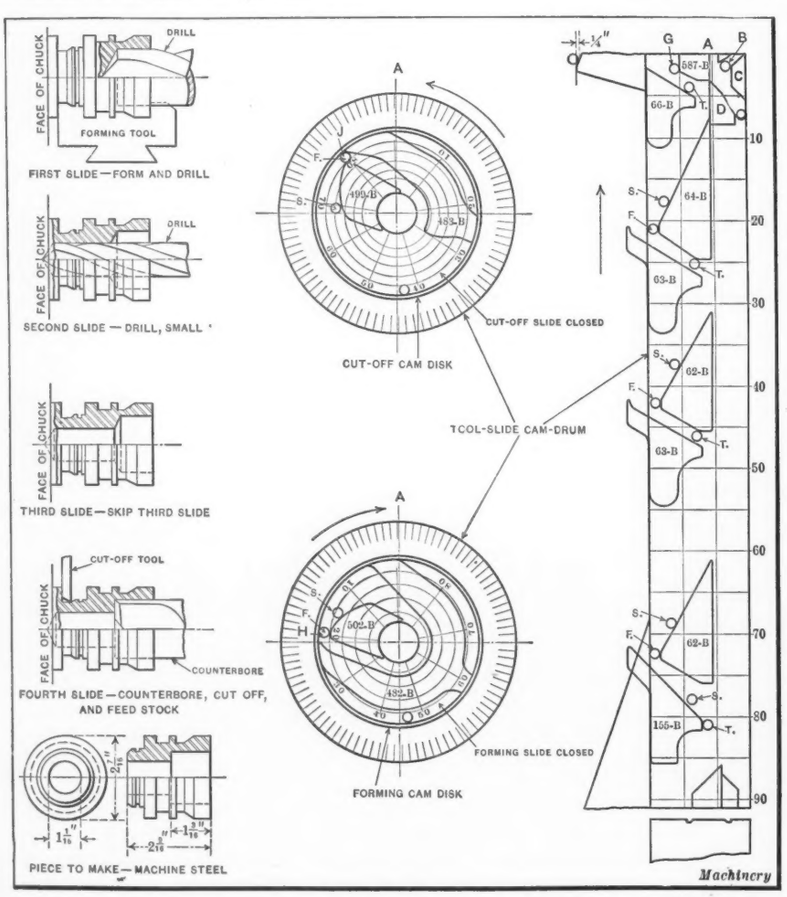

Fig. 17. Tooling Lay-out for Work in which Drilling and Forming Operations are performed at Same Time

Setting the Tools

The vertical forming tool and holder should be set to clear the spindle nose at the high point of the cam, and, at the same time, the large drill should be set at the required distance from the spindle nose. Set the stop for the stock at the required distance from the spindle nose; then place sufficient weights on the chain to feed the stock out to the stop and index from the corner stop position to the first slide. Crank the machine forward to the high point of the cam, watching the fast-feed dog, and adjust the forming tool for the height and diameter and set the stop for the slide. Index the

turret to the second slide and drill the small hole. It is advisable in all cases to set the various tools with relation to the face of the chuck before placing the bar of stock in the chuck, as in this way the setting of the tools can be approximately located without wasting any stock. After setting the small drill, index to the fourth slide, skipping the third slide, and set the counterbore. Next set the cut-off tool to cut off the piece and travel only into the small drill hole, not to the center of the chuck. This completes the setting of the tools, but it is necessary to make a few pieces, adjusting the slow- and fast-feed dogs on the operating drum so as to reduce the non-cutting movements and thus produce the part in the shortest possible time. It is also necessary in some cases to make minor adjustments of the cutting tools.

Making a Thin Washer

The thin washer shown in Fig. 18 is to be made from 4⅝-inch stock, and hence will be handled on the 5-inch machine. It should be noted that the corner stop cannot be used because it will not clear. This example shows drilling, counterboring, and reaming operations with the cut-off tool working continuously. As shown, the operations are accomplished in the following order:

Position	Operation
First	Form, bore with set-over tool, and cut off 5/8 inch
Second	Drill, turn, and cut off 3/8 inch
Third	Ream with strippers on reamer and finish cutting off 1/2 inch
Fourth	Feed stock to stop

The procedure to follow in setting the various cams, dogs, tools, etc., does not differ materially from the preceding, and is, briefly, as follows: The cams are set in the following order: Set cam 65-B, for counterboring, against roll *G*, and set the slow-feed dog on the operating drum for safety. Crank forward to the high point of the cam and set the continuous cut-off cam 229-B, which is made special for this job, to the high point of roll *J* on the first rise; also set forming cam 502-B to the high point of forming-cam roll *H*. Set the return cam 482-B, allowing clearance for the roll to pass. Set the fast-feed dog on the cam operating the drum at this point.

Set the tool-slide return cam 155-B, allowing clearance for the roll *G*, and crank forward until the roll *G* is flush with the high point of the return cam, setting the revolving dog on the operating drum at this point. Index the turret to the second slide and stop the machine. Crank forward to the high point of the cut-off cam—the second rise—and then set the cam 64-B to the high point of the turret tool-slide roll *G*, and set the fast-feed dog on the drum. Crank backward to the low point of the cut-off cam 229-B—the second rise—and set the slow-feed dog for safety. Now locate the tool-slide return cam 155-B, allowing clearance for the roll *G*, and crank until the roll *G* is flush with the high point of the return cam 155-B and set the revolving dog. Index to the third slide and set the high point of the tool-slide cam 61-B to the high point of the third rise on the cut-off cam, and set the fast-feed dog at this point. Crank backward to set the slow-feed dog at the low point of cam 61-B and set the tool-slide return cam 155-B, allowing clearance for the roll; also set the special return cam for the cut-off arm, allowing for clearance. The next step is to crank backward until the roll *G* is flush with the high point of the return cam 155-B and set the revolving dog. When laying out the special continuous cut-off cam 229-B, the first rise on the cam is made to give 5/8 inch travel of the slide; the second rise gives 3/8 inch travel, and the third, 1/2 inch travel. These rises are laid out so that they occupy about the same time as the operations performed from the tool-slides. The concentric portions of the cam are laid out to stop the travel of the slide while the turret is indexing. On the third slide, the piece is cut off and the work is removed from the reamer by the strippers when the tool-slide returns; the stock is then fed out to the stop in the fourth position. The tools are set in the manner previously described, and the final setting of the indexing, fast-feed, and slow-feed dogs is made after the machine is operating under power.

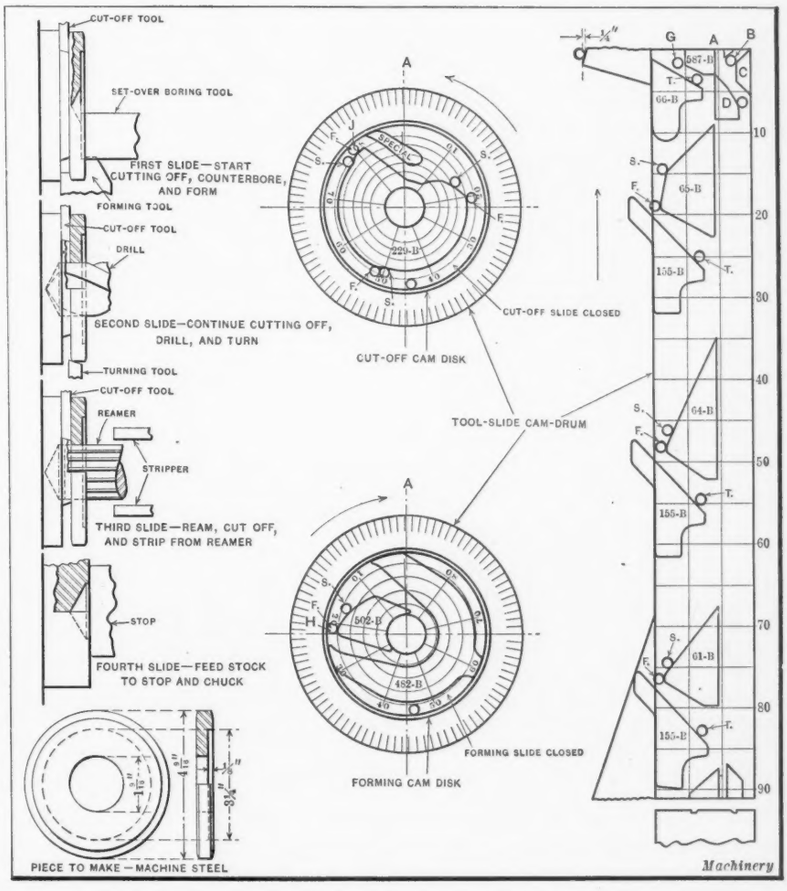

Fig. 18. Tooling Lay-out for a Thin Washer in which Cut-off Tool works continuously

Producing a Long Shaft

The third example is a long shaft, which illustrates a long forming operation, shown in Fig. 19. Owing to the length of this form, it is impossible to operate the forming tool at the same surface speed as the turning tool, so the order of the operations is as follows:

Position	Operation
First	Turn
Second	Form and support, using two rolls
Third	Skip
Fourth	Thread and cut off

This part is made from 1⅞-inch cold-rolled steel, and is handled on a 2¼-inch machine. As the corner stop is used, the fifth turret index-hole is not blocked. The first operation is to turn the bar for a distance of 4⅜ inches; then the turret is indexed to the second position, and the speed of the spindle changed to one-half the spindle speed used for turning. The bar is formed at the points indicated, and rolls held in special supports are brought in from the turret. In order that the rolls will remain stationary while the forming tools are at work, a special cam is used on the main drum; this cam is as long as the amount of circumference of the drum occupied by the forming operation. The third index-hole is plugged and the turret is indexed to the fourth position with the spindle still operating at the same speed as that used for forming.

The machine is run on the fast feed until the die has approached the work, when it is shifted to the slow feed, at which speed it is run until the die opens, when the spindle is

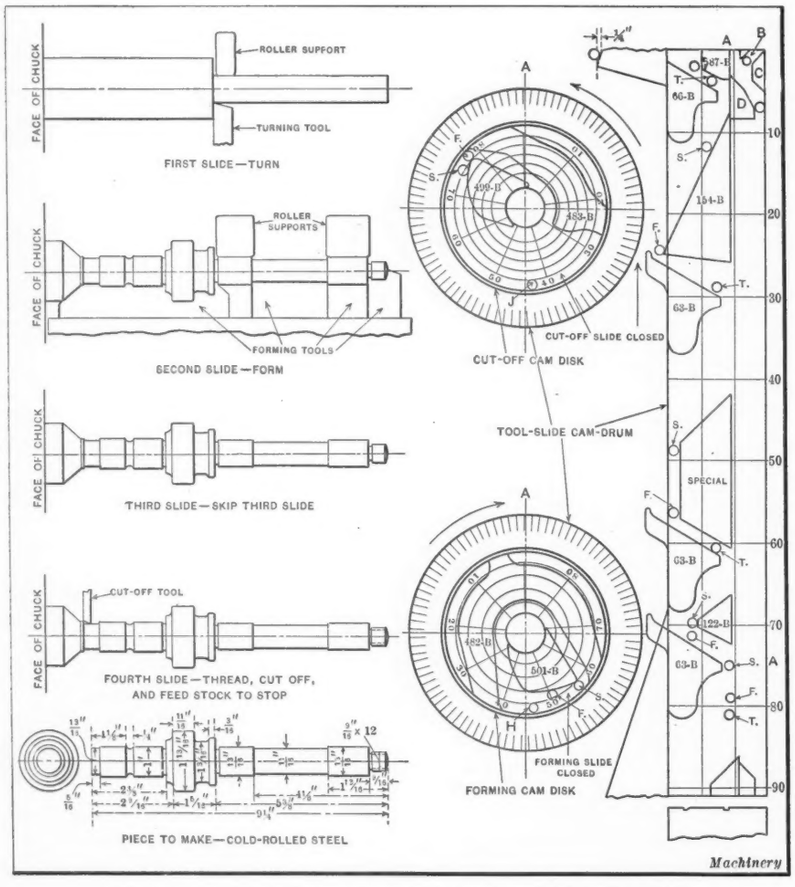

Fig. 19. Tooling Lay-out for a Long Shaft largely completed by Forming

changed to the fast speed again. The cut-off tool is now brought in on the slow feed and the piece cut off. As soon as the piece is cut off, the dogs are set to change to the fast feed and to index the turret. This series of operations is repeated on the next piece.

Producing a Long Sleeve with a Tapered Hole

The long sleeve with a tapered hole shown in Fig. 20 illustrates how drilling and turning operations can be accomplished at the same time, also reaming and cutting-off operations. The part is made from 4-inch cold-rolled steel, and hence will be handled on a 4¼-inch machine. The operations necessary to complete this piece are as follows:

Position	Operation
First	Drill and turn
Second	Rough-ream
Third	Form and support
Fourth	Finish-ream and cut off

The drill is the first tool brought into position, as it has to travel slightly farther than the turning tool, which is held on the same tool-slide. Cam 329-B is selected to give a feed that is suitable for both tools. The turret is now indexed to the second position and the work rough-reamed. It is next indexed to the third slide, where the work is formed from the forming slide and is supported from the turret by a special internal support. In order that the support will remain in position while the forming tool is at work, a special cam 65-B is necessary on the main drum. The turret is now indexed to the fourth slide, where the hole is finish-taper-reamed, and cut off. It will be noticed that the reamer is required to take a long taper cut to finish, so that the feed of the tool will be reduced at the end of the cut. This is accomplished by a special cam 278-B, which is cut away to give a fast feed to start, and to reduce the feed when the taper part of the reamer comes into action. The cut-off tool comes into action after the reamer has been fully withdrawn from the work. A fast-feed dog is set when the piece has been cut off and the turret is indexed and the series of operations is completed on the next piece. The full procedure to follow in setting the various cams and tools has not been included in the last two examples for the reason that the setting of the tools and cams does not differ materially from that described.

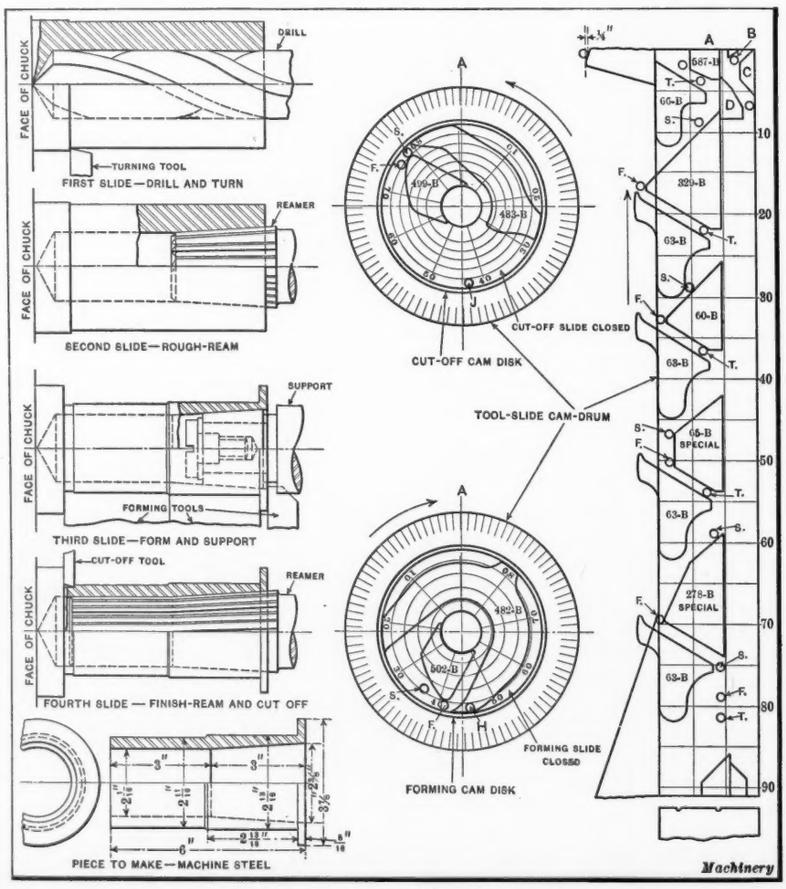

Fig. 20. Tooling Lay-out for a Bushing with Long Tapered Hole

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TINNING CAST-IRON VESSELS

A method has been developed by the French, according to *La Chronique Industrielle*, for tinning cast-iron vessels. To secure adhesion of the tin to the cast iron, the carbon must be removed from the iron or the vessel must be polished by mechanical means. To remove the carbon, the iron vessel is coated with oxide of iron or manganese, or enclosed in a box filled with this oxide, and subjected to a high temperature for from four to six hours. After this length of time, the iron is sufficiently decarburized to permit the adhesion of the tin. The iron vessel is then cleaned with dilute sulphuric acid, to which a little blue vitriol has been added, after which it is immersed in molten tin. If the interior is to be coated, molten tin, to which a little sal-ammoniac has been added, is vigorously rubbed over the surface. The vessel should be heated before the tin is applied, and the heating must be carefully done to prevent the oxidation of the surface.

MANUFACTURING WRIGHT ROLLER BEARINGS

MACHINING PARTS, HEAT-TREATING, ASSEMBLING, AND INSPECTING

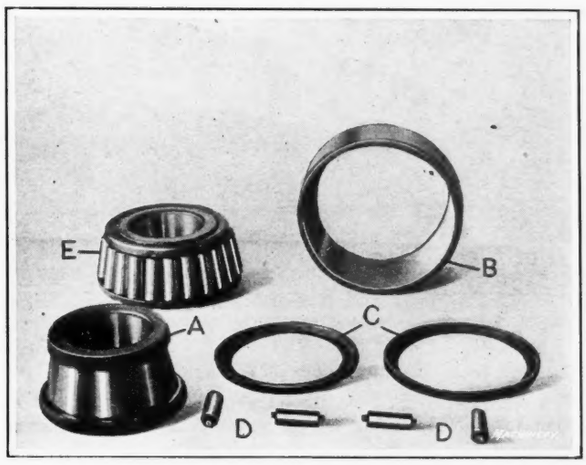

Fig. 1. Parts of Wright Roller Bearing before and after being assembled. A, Cone; B, Ring; C, Retaining Rings; D, Rollers; E, Assembled Cone and Rollers

THE Wright Roller Bearing Co. of Philadelphia, Pa., manufactures bearings for automobiles and commercial trucks. These bearings are made in a number of different sizes to cover a considerable range of load carrying capacities. All sizes are of the same design, and briefly stated, the component parts of a Wright roller bearing are the inner and outer raceways between which runs a series of tapered rollers; these rollers have a small pilot at each end so that they may be held in position on the inner raceway—at those times when the outer race is removed—by means of two sheet steel retaining rings. When the bearing is completely assembled, these retaining rings play no part in its operation, as the rollers are maintained in proper alignment by means of their taper, which causes each roller to automatically assume a position with its axis converging to a common point on the shaft axis, this point, of course, being located at some distance from the position at which the bearing is mounted. When the outer bearing raceway is removed, the retaining rings are depended upon to hold the rollers in position on the inner bearing raceway. From this description it will be seen that in the form in which it is shipped from the factory, a Wright roller bearing comprises two units, one of which is made up of the inner raceway, the rollers, and the retaining rings, while the other consists simply of the outer raceway.

It is the purpose of the present article to describe methods used in the Wright Roller Bearing Co.'s factory in manufacturing its product. Figs. 1 and 2 show parts of the Wright roller bearing. The inner raceways or cones are made from bar stock, which is machined on Gridley automatics. The inner cones are of the desired form when they leave these machines, with the exception that a "radius" has to be turned on the cut-off end, as shown at *A* in Fig. 2, and seats *B* and *C* have to be cut for the retaining rings. For performing the radial turning operation, the work is held in a Barker quick-acting chuck, which is made by the Thomas Elevator Co., 22 S. Hoyne Ave., Chicago, Ill., and the same type of chuck is employed for turning seats *B* and *C* for the retaining rings. In Fig. 3 is shown the operation of turning the radius at the small end of the cone.

Practice in Heat-treating Bearing Parts

The work is now ready to go to the heat-treating department, where the first step is to carburize the steel. This is done by the usual method of packing the bearing parts in boxes of carbonaceous material and subjecting it to a temperature of 1675 degrees F. for from eight to ten hours. The work is then removed from the carburizing boxes and placed in another furnace where its temperature is raised to 1550 degrees F., after which it is withdrawn and quenched in oil. A third heat-treatment is then given to the work by raising its temperature to from 1475 to 1500 degrees F. and quenching it in water. This procedure in heat-treatment is also followed in the case of the outer bearing races and the rollers, so that no further discussion will be necessary in connection with descriptions of the way in which these parts are made. This method of heat-treatment is the means of producing a very hard surface on the work. This department is furnished with Shore pyroscopes and Brown pyrometers.

Grinding Operations on Inner Cones

After being heat-treated, the work goes to the grinding department where the first step is to grind a flat surface *D*, Fig. 2, at one end of each cone. This is done by loading the work on a magnetic chuck mounted on a special surface grinder shown in Fig. 4. It will be apparent that this machine is a converted planer, and it is one of the oldest machines used by the company. Despite this fact, however, it is giving such satisfactory service that there seems to be no adequate reason for investing in a standard surface grinder to take the place of this special machine. It will be evident to the reader that this grinder has been made from a small sized planer. The magnetic chuck is placed on the planer table, while the special grinding wheel head is mounted on the regular ways on the cross-rail. The table reciprocates under the wheel and the regular power feed is used for feeding the wheel down until a stop is reached. The flat surface ground at one end of the inner cones by this machine, is used as a locating surface for the performance of subsequent grinding operations.

Next in order in performing the grinding operations on the cones comes the finishing of the inner hole *E*, Fig. 2, in the cone. For this purpose the work is held on a magnetic chuck mounted on either a Landis or a Bryant chucking grinder.

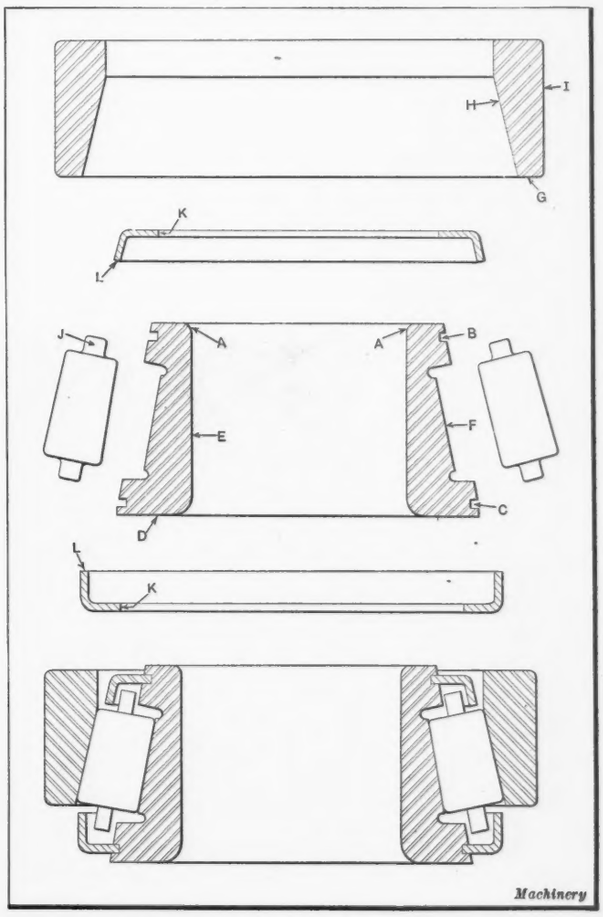

Fig. 2. Cross-sectional Views of Bearing Parts and Assembled Bearing

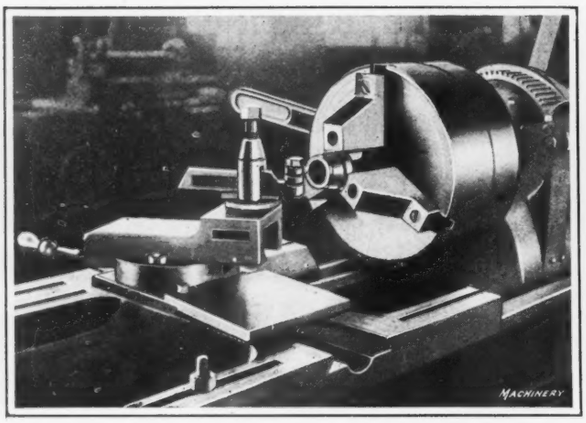

Fig. 3. Lathe equipped with "Barker" Quick-acting Chuck for holding Bearing Cones

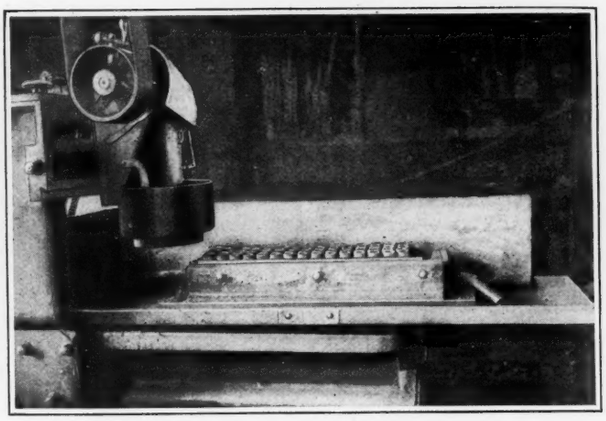

Fig. 4. Small Planer converted into Surface Grinder for grinding One End of Cones and Rings

It will, of course, be apparent that with the ground end surface held by the magnetic chuck, the hole will have to be ground at right angles to this surface. After this internal grinding operation has been completed, the cones are set up on a mandrel, which is located at the proper angle to the wheel-spindle of a Norton cylindrical grinder, so that a straight wheel can be used for grinding the roller track or raceway *F* on the cone. This is the final operation on these parts.

Machining Operations on Outer Bearing Rings

The rings in which the outer raceway for the rollers is ground, are made from bar stock which is machined on either 7½-inch Cleveland automatics, Fig. 7, or on Gridley automatics, according to the size of the work. After the rings have been turned on these machines, they are sent to the heat-treating department and subjected to the same treatment that is employed in the case of the inner cones. They are then brought back to the grinding room and ground on one end *G*, Fig. 2, on the machine shown in Fig. 4, which was described in connection with the grinding of the inner cones. The rings are next set up on either a Bryant chucking grinder, or on a Landis or Heald internal grinder, to provide for grinding the tapered hole *H*, Fig. 2, which forms the outer raceway for the rollers. As in grinding the inner cones, the Bryant and Landis grinders are equipped with magnetic chucks, while work ground on the Heald machines is held in collet chucks. In all cases the finished end surface of the ring is used as the locating point.

The final grinding operation on the rings consists of grinding the outer surface *I* on Norton cylindrical grinding machines, Fig. 8. For this purpose the work is held on mandrels, on which provision is made for holding from two to seven rings, according to their size. These mandrels are furnished with collars having a double taper corresponding to the ground inner surface in the work, so that two rings may be slipped onto each collar. The collars are then slipped onto the arbor, on which they are prevented from rotating by means of a key, and a C-washer, used in connection with the clamping nut that holds the collars on the arbor, makes it necessary only to loosen the nut to remove the collars.

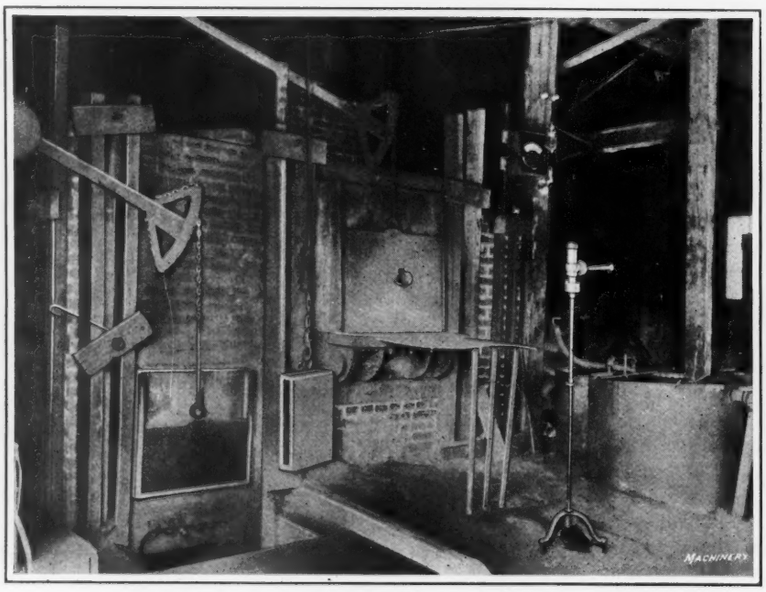

Fig. 5. Furnaces in which Cones, Rollers, and Rings are hardened

Making Conical Rollers

The conical rollers used in Wright bearings are made on National-Acme automatic screw machines. In this connection attention is called to the fact that the rollers are centered at the end in order to provide means of holding for a subsequent grinding operation. The next step is to subject the work to the same process of heat-treatment which has been described for the cones and rings of the bearings. After heat-treatment the grinding is done on a Landis machine shown in Fig. 6, which is equipped with a collet chuck that grips the small pilot *J*, Fig. 2, at one end of the roller, while a quick-acting center, manipulated by lever *A*, Fig. 6, engages the opposite end of the roller so that it is firmly supported for grinding. In loading the machine, a roller is placed in clip *B*, which is manipulated by push-rod *C*. After a roller has been put in position in the clip, rod *C* is pushed forward so that the roller is brought into line with the collet chuck of the machine. Lever *A* is then operated to cause the center to engage the opposite end of the roller and push it over sufficiently so that the pilot on the roller enters the collet chuck.

Inspection of Rollers before Assembling

After being ground, the rollers must be very carefully inspected, both for finish, taper angle, and size. The inspection room is divided into several departments, and rollers arriving in the inspection room are first looked over by inspectors whose duty it is to determine the perfection of finish of each roller. All work which passes this inspection satisfactorily is sent to a second department where the inspectors use angle-gages of the form shown at *A* in Fig. 9. These gages have knife-edge blades, between which the rollers are placed, and if any light shows between the work and the knife-edges of the gage, it shows that the angle is incorrect, and such defective rollers are, of course, immediately rejected.

The actual size of rollers in a bearing is not of vital importance, but it is absolutely important for all the rollers in a bearing to be of exactly the same size. The reason for this is that, if there is any difference between the size of adjacent rollers, all of the load will be concentrated on the larger sized rollers, while those which are

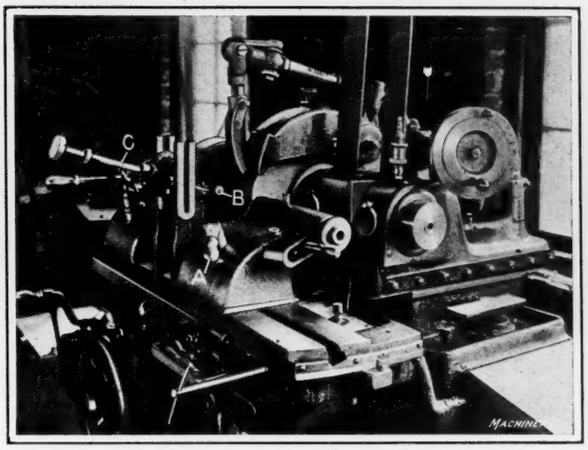

Fig. 6. Landis Grinding Machine with Special Means for loading and holding Rollers

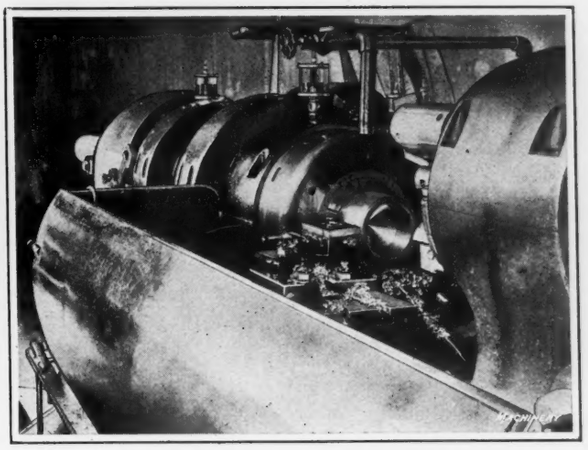

Fig. 7. Cleveland 7½-inch Automatic Screw Machines for turning Outer Rings

of smaller diameter will not be carrying their proportion of the load. On this account it is the practice to gage the rollers with a special dial indicator, shown at *B*, which has a V-block in which the roller is placed while being measured by a dial test indicator reading to 0.0001 inch. This indicator is set at such a distance from the V-block that when in contact with a roller of absolutely the required size, the needle will stand at zero on the dial of the instrument. By the help of instruments of this type, the rollers are sorted out into seven different grades, as follows: — 0.0015, — 0.0010, — 0.0005, O.K., + 0.0005, + 0.0010, + 0.0015 inch.

Placed on the inspection bench there are sheet-metal flaps shown at *C*. Each of these flaps has seven holes marked with the sizes of the seven classes of rollers, to which reference has just been made. As the inspectors measure each roller under the dial indicators, they drop it through the hole in the flap, which is marked with the size to which the roller has been found to belong. The roller drops through the hole in the flap into a chute leading to one of seven bins in which the different sizes of rollers are stored pending their delivery to the assembling department. Each of the sheet-metal flaps *C* is hinged, and when an inspector drops a roller through the flap he pushes it down. A Veeder automatic counter is geared to each flap so that in this way a record is kept of the number of rollers which are passed by the inspection department. In assembling bearings, rollers of the same size are put into a bearing so that the load to be carried when finally placed in service will be equally distributed over the rollers, in the way which has already been described.

Making Retaining Rings

Attention has already been called to the fact that the rollers used in Wright roller bearings have a small pilot at each end. The purpose of these pilots *J*, Fig. 2, is to fit under retaining rings so that the inner cone, the rollers, and the retaining rings may be held together in a single unit as shown at *E*, in Fig. 1. The retaining rings which are shown at *C* in Fig. 1 are blanked, drawn, and punched in a combination die and double-acting power press, which completes the press work on the rings at a single operation. From this machine they are taken to a speed lathe, on which the punched hole *K*, Fig. 2, in each ring is finished and the outer edge *L* turned down in order to obtain a good finish and to have the flange on the ring of exactly the desired length.

Assembling Bearings

In assembling, the first step is to press the retaining ring into its seat *C*, Fig. 2, at the large end of the inner cone, this operation being performed on an arbor press. The cone is then placed on a table with the large end down, and a complete set of rollers is dropped into place in the retaining ring. The outer bearing ring is then dropped into place over the rollers in order that the raceway in this ring may align the rollers properly. After this has been done, the retaining ring is dropped into place on the small end of the cone and pressed into its seat *B* with the arbor press. The flanges on the retaining rings now hold the rollers in place so that the outer ring may be removed, leaving the rest of the bearing as a self-contained unit, as shown at *E* in Fig. 1. The assembled bearings are next subjected to a general inspection, after which they are thoroughly cleaned, oiled, and wrapped in wax paper preparatory to being boxed for shipment. E. K. H.

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An investigation of the heat-insulating efficiency of various materials, made by the United States Bureau of Standards, shows that gypsum is the most efficient fire-insulating material. The dense, high-plaster mixtures give much better results than the porous, low-plaster, high-water mixtures. Concrete and clay vary somewhat in their insulating efficiency, depending on their porosity. The denser clays conduct the heat a little more rapidly than the concrete, while the more porous clays conduct heat somewhat less rapidly. The effect of the aggregates on the conductivity of the concrete is not very marked; there is very little difference between gravel, trap rock, clay and soft-coal cinder aggregate. Limestone concretes, however, seem to give a much lower conductivity.

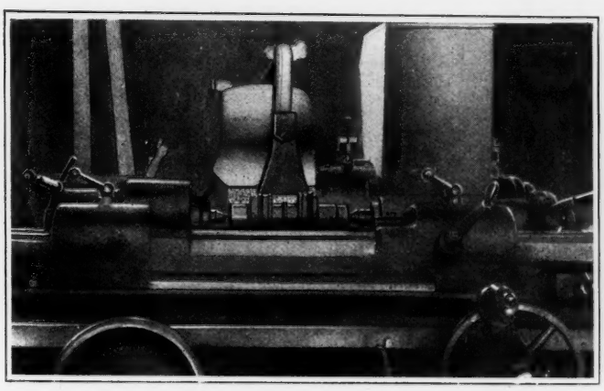


Fig. 8. Norton Plain Grinding Machine with Special Mandrel for holding Outer Rings

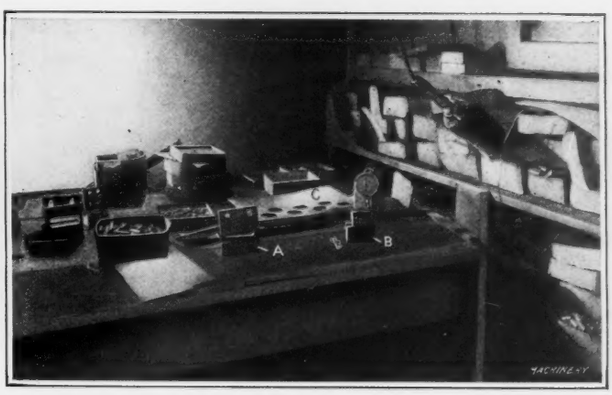


Fig. 9. Inspection Bench with Gages for testing Taper and Size of Rollers before they are assembled

NOTCHING AND ASSEMBLING PUNCH AND DIE FOR SHELL FUSE SOCKET

BY DONALD A. BAKER[1]

As shown in Fig. 1, the fuse socket of the U. S. three-inch shrapnel shell consists of a steel forging, machined as shown, which has inserted in it a thin sheet-metal disk *A*, swaged in place. The operations about to be described are the assembling of this disk and the cutting of the five notches *B*, which are performed simultaneously. It is not necessary to hold these notches closely to dimensions or any degree of smoothness, as their only use is to hold the fuse in place after it is assembled and screwed in. As first planned, the five notches were to be cut on hand milling machines fitted with suitable indexing fixtures. Based on a production of twenty thousand pieces per day, this would probably have meant the installation of about ten machines for this work alone; besides, a press operation would have been necessary later to assemble the disks. As three dies are enough to handle this production, it is hardly necessary to say that it pays to use considerable judgment and thought in the selection of methods on work of this kind. The unique idea involved in this die is the use of pivoted arms in place of the slides that are frequently found in shops handling sheet-metal products that require operations on several sides at the same time.

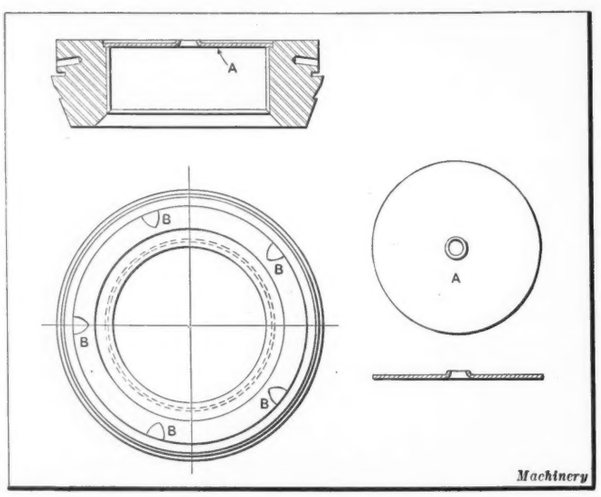


Fig. 1. Fuse Socket for Three-inch Shrapnel Shell

The die, shown in Fig. 2, consists of a cast-iron base or shoe *A*, into the center of which a hardened and ground steel post *B* is driven. Over this post is placed a soft steel spider *C*, into which is driven a hardened steel bushing *D*, which is a sliding fit on the post. This spider carries five punch-holders, or pivoted arms *E*, made of machinery steel, pack-hardened and ground. The punches *F* are shown with their backing-up and adjusting screws *G* and *H*, while at *I* is shown the locating plug over which the fuse socket is placed. The pins *J* and *K* take the thrust of the pins *L* and actuate the pivoted arms when the press is tripped; one of these pins *K* is slotted at the top, as shown, to prevent the spider from turning on the center post and throwing the arms out of alignment with the pins.

The body *M* of the assembling punch and punch retaining ring *N* are of soft machinery steel. The punch proper is shown at *O*, while *P* is a spring plunger, the purpose of which will be explained later. A spring attached to the press bolster plate or direct to the die-shoe, if more convenient, is used in connection with the push-rod *Q* to hold the spider at the top of its stroke ready to have the work placed in position over the locating plug *I*.

In operation, the punch and die works as follows: The fuse socket, top down, is placed over the locating plug *I*, the disk having been put in place in the bottom of the socket. Then, as the press is tripped, the punch descends, and the pilot on the end of the spring plunger *P* enters the hole in the disk to make sure that it is perfectly central. As the punch continues its downward movement, the outer edge of the spring plunger, backed up by the spring pressure, seats the disk firmly, and the punch *O*, coming into contact with the base of the fuse socket, forces the socket downward together with the spider *C*. As the spider moves downward, the pivoted arms *E* are forced inward by their contact with the pins *J* and *K* and cut out the five notches. The die is so planned that, as soon as the notches are cut, the spider bottoms on the end of the central post, and thus offers resistance enough for the punch *O* to swage the edge of the fuse socket base in and around the disk. To reduce the pressure required for this operation, the face of the swaging punch is corrugated or knurled deep enough so that only a part of it is used to accomplish the work.

On the up-stroke of the press, the spider is returned to position by means of a spring located under the die, which forces the push-rod *Q* upward, while the pivoted arms are returned to position by means of springs. The latter are not shown, as they were not thought necessary at the time the design was made. The speed of this particular die, of course, depends on the skill of the operator, but the average production is between 7000 and 8000 pieces per day.

* * *

The French Committee on Women's Work has raised the prohibited age for night work from sixteen to eighteen years. Night work for women must not exceed six hours actual work, must not be instituted if the output can be maintained by day work, and must be the first work to be cut off when reductions of output occur.

[1]Address: Care of Service Engineering Co., 25 Church St., New York City.

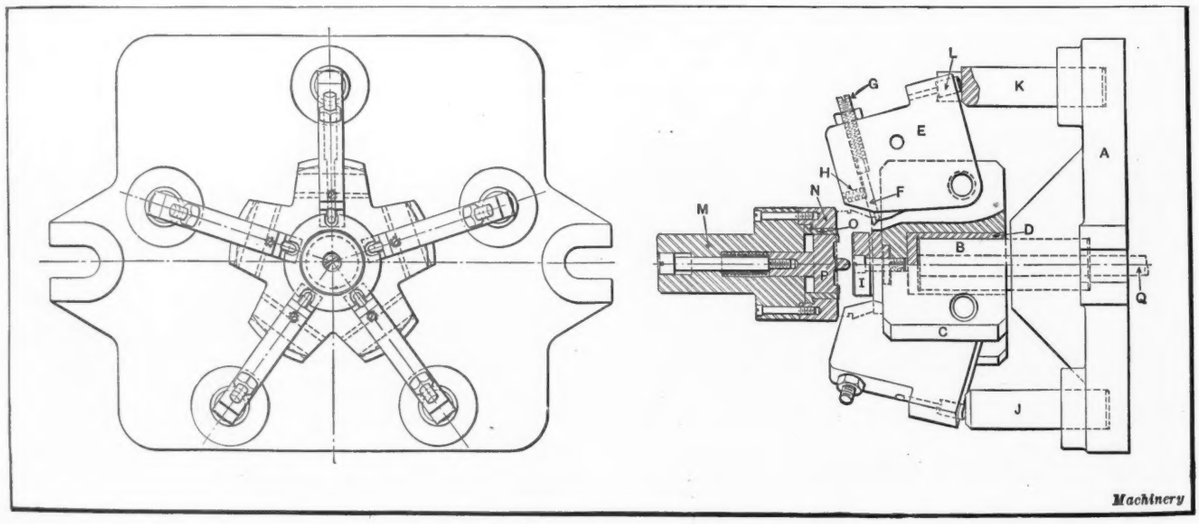


Fig. 2. Punch and Die for notching and assembling Fuse Socket

GRINDING AND LAPPING THREADS

ATTACHMENTS, FIXTURES, AND LAPS USED FOR PRODUCING ACCURATE THREADS

BY J. E. LINDGREN[1]

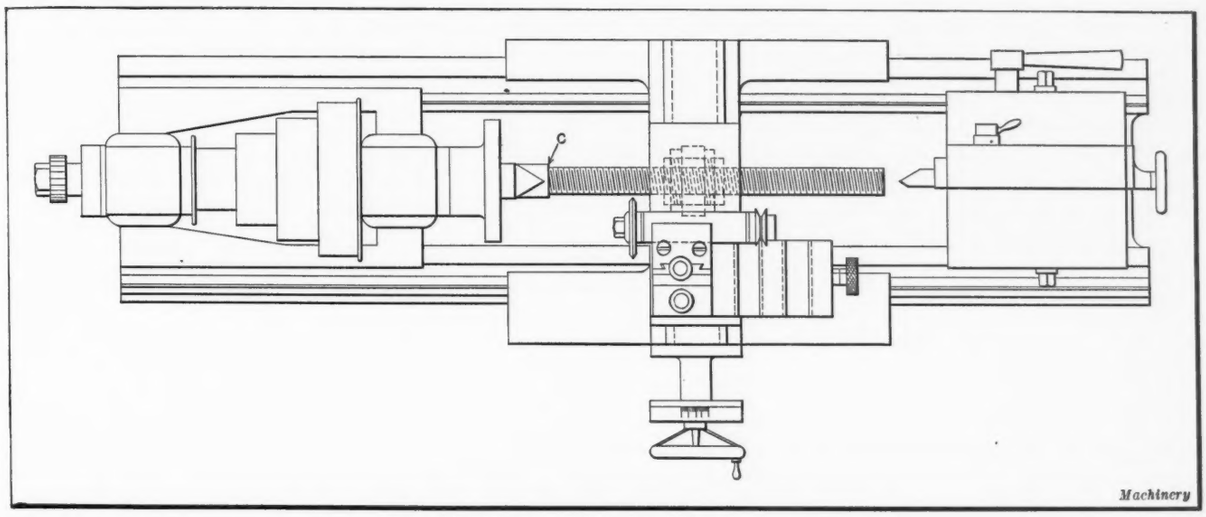


Fig. 1. Thread-grinding Lathe used in the Production of Accurate Threads

A SPECIAL thread-grinding lathe is shown in Fig. 1. Although this machine was designed for thread grinding only, it can be changed into a thread-miller by making a worm-wheel drive for the main spindle and also for the spindle on the grinding fixture. It will be noticed that this lathe is not provided with back-gears. This is because back-gears are objectionable on grinding lathes. The countershaft can be slowed down so that when the belt is placed on the largest step of the cone pulley the spindle will make 60 revolutions per minute, which would be the right speed for grinding a thread gage 3 to 4 inches in diameter. The lead-screw of this lathe is placed in the center of the lathe bed so that the pull on the carriage will be in the center. This obviates any possible twisting of the carriage and uneven feeding. Of course, the lead-screw has to be well covered, as it is necessary to use water in grinding a thread, and this would ruin the lead-screw if it were not protected.

The lead-screw is made on a master thread-cutting lathe and is made only long enough to provide feed for the work to be ground. It is not necessary to support one end of it, as it has three bearings, namely, the two brackets underneath the headstock and the nut under the carriage, which takes the place of one end bearing. It will be noticed that this nut is solid and not made in halves, as is the custom on other lathes, because it has been found that it is best to reverse the lathe when going back to take another cut. The solid nut also makes the carriage feed more rigid. The lead-screw can be disconnected from the drive shaft at *C*, so that when it becomes worn a little, it can easily be replaced. The tailstock and tailstock sleeve are cut away to let the grinding fixture pass when grinding very small plugs. The wheel that is used is only about 3 inches in diameter when new. The carriage is provided with a cross-slide and a compound slide, the cross-slide being adjusted with a fine-pitch screw of twenty threads per inch, so that the dial on the screw can be graduated to ten-thousandths; this is very necessary because in finish-grinding a thread it is necessary to move the wheel only 0.00005 inch to a cut, the dial being large enough to make the graduation lines about 1/32 inch apart. The compound slide has no graduated dial, as it is used only for adjusting the wheel to the thread groove.

The gearing for driving the lead-screw on this lathe should receive especial attention. Being a lathe of about 12 inches swing, it is advisable to make the gears of very fine pitch, say 20 diametral pitch, and as the gears will be small in diameter, they are made of steel. The gears must be turned and milled with the utmost care, because if they are not true, they will not drive the screw evenly, and drunken threads will be the result. As this lathe has no feed except the screw feed, it does not require an apron. The machine is simple and inexpensive to build and will be found very accurate and efficient. When grinding a thread, water must be used. It is therefore necessary to provide this lathe with a pan, tank, and a circulating pump; the top of the machine can be protected by covering it with heavy oilcloth. The kind of wheels to be used for grinding threads is a hard matter to decide upon, but by experience the writer has found that a 180-J carborundum wheel will give satisfactory results for grinding any thread having not over twenty-five threads per inch. If a finer thread is to be ground, an India oilstone wheel will be found satisfactory.

[1]Address: 1242 Oak St., Beloit, Wis.

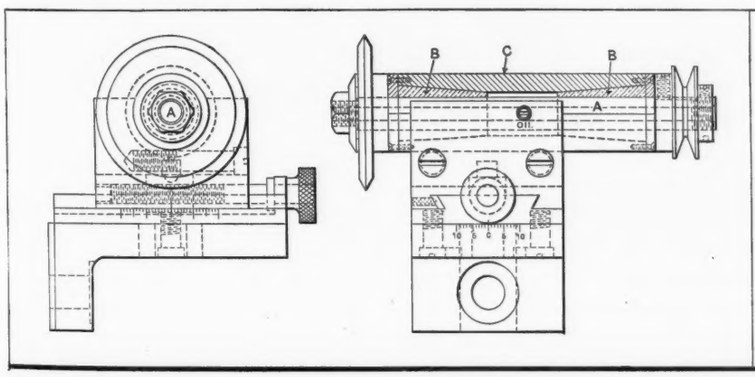


Fig. 2. Thread-grinding Fixture

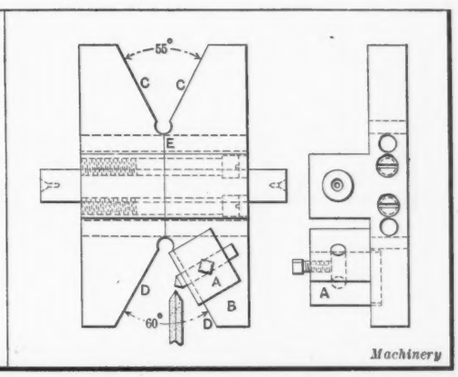


Fig. 3. Fixture for dressing Grinding Wheel

The thread-grinding fixture shown in the side elevation and plan view in Fig. 2 is designed to do accurate grinding at a high rate of speed. The wheel can be set at any angle to conform to the helix angle of the thread, and it can also be adjusted up or down to bring the center of the wheel in line with the center of the work being ground. In making a grinding fixture, one must bear in mind that it cannot be machined too accurately. The most important part of this fixture is the spindle *A* and its bearings *B*. The spindle, being made of tool steel, is hardened and ground. It is well to make it of some oil-hardening steel that will not change much, if any, when hardened. It will be noticed that the spindle is hollow, so that it will be cooled when running simply by the air passing

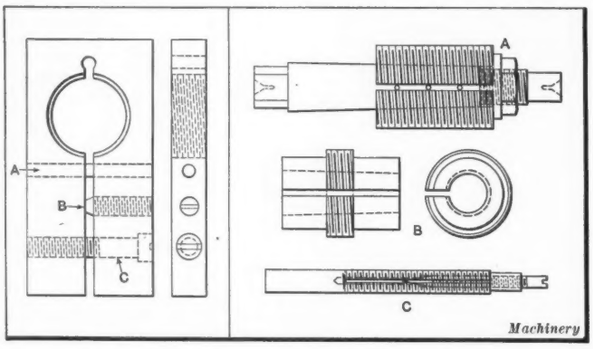


Fig. 4. Lap for Plug Gage

Fig. 5. Laps for Ring Gage

through it. The bearings *B* are made of some good bearing bronze, and it is necessary that they be absolutely concentric. The casing *C* is a cast-iron sleeve with a taper hole in each end for receiving the bearings. These taper holes should be in line with each other. To obtain the accuracy desired, first grind one hole to fit the bearing; then put a plug in the chuck and grind this to fit the taper hole that is ground. Then place the casting on the plug and tap it lightly. If the other end is ground in this position, these two taper holes should be true with each other. It is also necessary to have the ends concentric with the holes, so they should be held on the plug while grinding.

A block for dressing grinding wheels is shown in Fig. 3. This block should be hardened and ground all over, and it should be lapped at *C*, *D*, and *E* and tested with a sine bar. The hole through the block which is to receive the arbor must be true with *C*, *D*, and *E*. This fixture is simple in design, but can be made very accurately and will dress a wheel so that the only lapping necessary on the plug or ring gage is merely to remove the vibration marks. These vibration marks are so small that they will not be seen until a lap is applied. When using a block or fixture like this for truing the wheel, it is possible to grind a plug or ring gage almost to size. This will increase production, because it requires less time to grind than it does to lap. To use this block, simply put it between centers. A small jack should be put underneath it to keep it from turning. By sliding the small block *A* that carries the diamond against the angle of the large block *B*, taking care to press slightly against it, the wheel can be dressed. With a little practice, no difficulty will be experienced in handling it, and the writer ventures to say that a wheel can be accurately dressed in about two minutes.

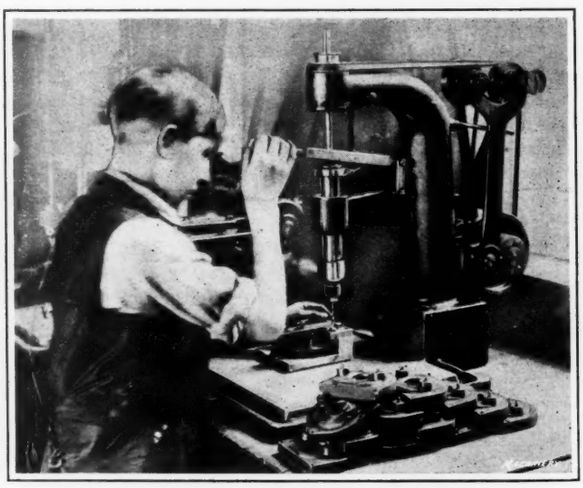
To lap a thread is a very easy matter if one has good laps. When a thread plug gage is to be lapped, the procedure is as follows: First make a tap and grind it on the master lathe to sizes corresponding to the plug before the plug is lapped. Good practice requires that there should be about 0.0005 inch to lap all over. After the tap has been made, inspected, and found to be all right, the lap can be made as shown in Fig. 4. This is made of very soft cast iron. It has a guide pin *A*, adjusting screw *B*, and a screw *C* for locking. To use the lap, simply adjust it to the plug thread, put on some lapping compound, and turn the plug back and forth a few times; then remove the plug and reverse the lap. Care must be taken not to run the lap over the plug loose, as this will ruin the shape of the thread, and if it is too tight, it will cause overheating. It will often be found that the plug has a tendency to become smaller at each end. To remedy this, a narrow lap must be used so that the high points can be lapped off. A good lapping compound is made by mixing flour carborundum with vaseline; the amount of each will vary according to the amount of stock on the plug. In this case, use a mixture of 8 parts of vaseline to 1 part of flour carborundum for rough-lapping. For finish-lapping, use 16 parts of vaseline to 1 part of flour carborundum. When lapping, wash the plug and lap often in gasoline to remove the fine steel chips that are produced.

Three laps are shown in Fig. 5 for lapping ring gages, *A* and *B* being made for large ring gages, and *C* for smaller sizes. They are made of cast iron and are ground to fit the ring gage to be lapped. Grinding the thread on a lap will insure accuracy. Lap *A* is designed for roughing, and has a tendency to make the ring bell-mouthed. Therefore, it is necessary to use a lap with only a few threads, as shown at *B*, for finish-lapping. With this lap, it is possible to obtain a ring which is straight from end to end. The lap shown at *C* is for small sizes, and as it will expand at one point only, one lap is sufficient.

* * *

DRILLING BAKELITE AT HIGH SPEED

At the plant of the Johns-Pratt Co. in Hartford, Conn., it is necessary to drill parts made of bakelite, three holes 1/8 inch in diameter being drilled through a thickness of approximately 1/16 inch. Trouble was experienced in handling this work through rapid destruction of the twist drills by chipping the cutting edges when the work was done on a drilling machine running at from 3000 to 3500 revolutions per minute. Recently, the Fenn Mfg. Co. of Hartford, Conn., developed a sensitive drilling machine adapted for operation at speeds ranging from 10,000 to 15,000 revolutions per minute, and after the trouble experienced in drilling bakelite had been called to the attention of this firm of machinery builders, one of the high-speed sensitive drilling machines was sent to the Johns-Pratt Co.'s factory for trial on this work. After preliminary experiments had been conducted, it was found that operating at a speed of 11,000 revolutions per minute, the machine gave extremely satisfactory results on this work, and it has now been in operation for several months, giving ample time to obtain results which are quite representative of average conditions. Running at this speed, the machine drills in excess of 6000 holes per day, i.e., the production is over 2000 pieces per day. The machines have been successfully used for drilling small holes in metal where the high speed enables the small letter sizes of drills to be run at efficient cutting speeds.



Drilling Bakelite on High-speed Sensitive Drilling Machine built by Fenn Mfg. Co.

A feature of this Fenn high-speed drilling machine is the arrangement of the feed lever which, it will be seen, is counterweighted with the spindle, so that all of the pressure applied by the operator to the lever goes direct to the drill point. This makes the machine very sensitive and greatly reduces the possibility of breaking drills. E. K. H.

RECENT PROGRESS OF PYROMETRY[1]

Considerable progress has been made in the manufacture of pyrometers during the past five years, several new instruments having been introduced for industrial and scientific purposes. Various investigations of fixed points have been made, and it has been found that, up to the highest reading obtainable on the gas scale—1550 degrees C.—the present-day standards are apparently fixed. The melting point of platinum is accepted as 1755 degrees C., which is a useful calibration point for high-reading pyrometers. The United States Bureau of Standards issues data on certified fixed points of materials for calibration, which, if accompanied by instructions, would eliminate the danger arising from the use of materials of unproved purity.

Thermo-electric Pyrometers

Base-metal couples, though their dependability has been questioned, are being extensively used in place of the more expensive platinum and platinum alloy junctions. Trials made on couples of the base-metal class, show changes in calibration, on heating for twenty-four hours, ranging from 20 to 130 degrees C. Errors of this nature are practically eliminated, however, if care is taken in selecting materials and in "ageing" the junctions by prolonged heating at the maximum temperature before calibrating. Base-metal couples develop a relatively high electromotive force and permit the use of strong, cheap indicators in place of the sensitive instrument required for platinum junctions. Among the base-metal couples the following are prominent; copper-constantan for temperatures below 700 degrees C., iron-constantan, which may be used to 900 degrees C., two iron-nickel alloys of different composition, which will register 1000 degrees C., and two nickel-chromium alloys capable of reading to 1200 degrees C. in continuous use, and to 1300 degrees C. for occasional observations. A thermo-couple of carbon and graphite gives promise of a valuable extension in the range of thermo-electric pyrometers, readings as high as 2000 degrees C. being attainable. This junction should be heated to this temperature before calibrating, in order to expel volatile matter. Among the materials which have recently been introduced for protecting the unions from the corrosive action of furnace gases are: alundum (oxide of aluminum), which melts at 2050 degrees C.; and silit and silfrax, which are brittle substances resembling carborundum. Junctions used in reading temperatures of molten brass and bronze, are successfully protected by a tube of molybdenum.

A new departure in commercial indicators for thermo-electric pyrometers is the adoption of the potentiometer principle, the connections for which are shown in the accompanying illustration. B is a two-volt accumulator, R_1 an adjustable resistance, R_2 a fixed resistance, DE a uniform ohmmeter, A a switch, S a standard cell, and G a sensitive galvanometer of potential along DE. In order to maintain a steady stretched wire, R_1 is adjusted so that when S is switched into the circuit of G no deflection is observed. This adjustment must be made from time to time, as the voltage of B diminishes with use. The pyrometer is connected to one terminal of G and to a sliding contact which, when taking a reading, is moved along DE until no deflection is noticed on G. From the known constant for the junction used, DE may be graduated to read temperatures directly. Although the readings are not automatic, this method has the advantage of providing greater sensitiveness and independence of the resistance of the pyrometer and leads. An indicator has been substituted for the galvanometer for special-range readings. The slider is fixed at any given point above which higher readings may be taken, the fixed point being considered as zero. Suitable adjustments of the sliding contact along DE gives the range required. A suspended-coil indicator may also be used in this circuit. In the multi-range instrument made by R. W. Paul, the indicator replaces the galvanometer in a Wheatstone bridge circuit, the pyrometer being in series with the indicator. By throwing the bridge slightly out of balance, an opposing current to that produced by the thermo-couple is made, which, when overcome, will move the pointer. Resistances placed in the arm of the bridge, disturb the balance until the low reading of the selected range is reached. The variation in the temperature of the cold junction is recorded and automatically corrected, by the use of two copper and two manganin resistances in the arms of the bridge, since copper changes its resistance with the temperature, while manganin remains constant. An indicator unaffected by vibration and affording a high degree of accuracy, for use in regulating temperatures of superheated steam on locomotives, is now being produced.

[1]Abstract of a paper read before the Royal Society of Arts by Charles R. Darling.

Resistance Pyrometers

Platinum is distinctly volatile above 1000 degrees C., which explains the change that takes place in calibration when resistance pyrometers are employed for higher temperatures than this. For accurate results below this temperature, this type of pyrometer is much used, although the temperature to be measured must be subject to absolute control. A liquid element, such as melted copper, showing a uniform increase in resistance up to 1400 degrees C., might be utilized in extending the range of the resistance pyrometer.

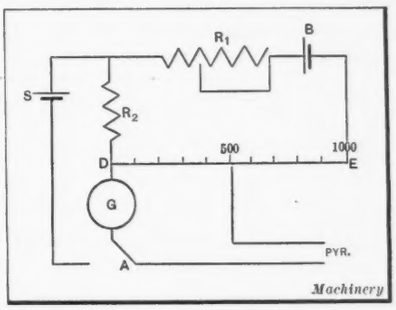


Diagram of Potentiometer Indicator

Radiation Pyrometers

A distinct improvement in these instruments has been the substitution of pivoted indicators for the suspended-coil type. More sensitive junctions, also, are being used. To determine the temperature of molten metals, the pyrometer may be mounted at the open end of a fireclay tube, and permanently focussed on the closed end, which is immersed in the metal. A salamander immersion tube is also used, the telescope being pierced by a tube, open at each end, through which air may be forced, preventing fumes from reaching and corroding the mirror. Another instrument of this type receives the rays in a tube containing a polished cone, a junction at the apex receiving the radiations. The same reading is obtained anywhere within a given limit, therefore requiring no focussing. A high degree of accuracy is now being attained with radiation pyrometers.

Optical Pyrometers

New types of optical pyrometers have recently been introduced, based on the principle of color extinction. In one form, cells containing a liquid of the correct color and density are used, the luminous rays from the heated object being extinguished at a given temperature. The instrument is an eye shade, in which four cells are mounted, two of which are capable of extinguishing the light at the working temperature, while the other two correspond to a slightly higher temperature. Either pair may be brought before the eyes by moving a slide, and when the heated object is barely visible in the lower pair, but invisible in the higher pair, the correct temperature has been attained. Another form has a single cell, in which the depth of liquid may be adjusted until the object is invisible, and the temperature readings taken on a scale, graduated according to the depth of the liquid. Still another form consists of a small telescope, through which the rays are intercepted by a dark-colored glass wedge, which is moved, together with a scale, until the sighted object just ceases to be visible. Temperatures are read from the scale, and the range may be increased by inserting tinted glass in the eye-piece, and reading from a second scale which has been prepared with the glass in position.

Recorders

Recorders for registering the readings of several pyrometers simultaneously are also receiving special attention. Of the more recent types, Foster's recorder possesses an indicator pivoted horizontally, the pointer being vertical and moving

across a circular chart, which rotates about its center once a day. A black mark is made on the chart at regular intervals, by means of a presser bar, working against the pointer, at the end of which is a capillary tube containing an inked wick.

In the latest thread recorder of the Cambridge Scientific Instrument Co., two threads are used, differently colored, and two indicators which record on a single chart. A mechanism which brings the threads alternately beneath the pointer produces four simultaneous records. The pyrometers are automatically switched onto the indicators in correct sequence.

Recorders with motor-driven mechanisms have been introduced by the Leeds & Northrup Co. and also by R. W. Paul. The latter also has other novel features. The chart is in the form of a continuous roll, of 1000 hours' duration, a large part of which is visible through a window extension. The mechanism which produces a dot periodically on the chart, may be varied in speed by inserting change-gears. The chart of the Siemens recorder is similar to the chart just described. It is furnished with a pivoted galvanometer. Clockwork is used to actuate this instrument.

* * *

SHIP TONNAGE

At the present time the term "ship tonnage" is frequently used in papers and periodicals. The general lack of knowledge in regard to the meaning of this term tends to confuse a great many people. This confusion may be attributed to the fact that the expression has five distinct meanings. Referring to merchant ships, the gross tonnage has nothing whatever to do with the weight of the ship nor the weight of the cargo, but pertains rather to the entire carrying capacity of the ship, expressed in tons of 100 cubic feet. The *Mauretania* is referred to as a ship of 32,500 tons, meaning gross tons.

Net tonnage, or registered tonnage, as it is often spoken of, is expressed by the same unit that is used in determining gross tonnage, that is, 100 cubic feet, but is figured exclusive of all space not adapted to the carrying of cargo, such as engines, boilers, bunkers, etc. The net tonnage of a merchant ship is registered on the records of the country whose flag it flies, and is what is generally implied when tonnage is spoken of.

Dead weight tonnage is the weight of the cargo in tons of 2240 pounds which the ship will carry. Dead weight tonnage is frequently referred to when speaking of ships which carry heavy cargoes, such as iron or coal, as tons, but in other cases the expression "dead weight tons" is used. A coal barge of 7500 tons would have a net tonnage of only approximately 3200 tons. When the ocean rate is quoted as so many dollars per ton, either measurement tonnage or dead weight tonnage is understood to be meant. Measurement tonnage is the amount of space occupied by the cargo, and the unit used is only 40 cubic feet. A ship can carry a cargo measuring 2½ times its net tonnage. On light, bulky cargoes, measurement tonnage is figured, while on heavy cargoes, the rate is figured on weight. The classification of the method of figuring the tonnage is optional with the owners of the vessel.

Displacement tonnage has to do with battleships exclusively, and is the actual weight of the water displaced by the ship, when fully equipped, or, in other words, the weight of the warship in tons of 2240 pounds. One very unfortunate outgrowth of the confusion arising from misunderstanding of the meaning of the word "ton" has been to deceive the layman as to the seriousness of the whole situation as regards ship production. During the year 1917, about 7,000,000 tons of shipping were sunk, yet this does not seem so alarming, for, according to reports, the United States alone is scheduled to build 6,000,000 tons during the present year, exclusive of that which is being produced by the other allied nations. Therefore, it would seem that the construction would overbalance the destruction. The fact is that the 7,000,000 tons sunk were net tons, while the 6,000,000 tonnage planned for 1918 does not represent net tons, but dead weight tons. The seriousness of the situation is apparent when it is understood that it requires fully two dead weight tons to equal the one net ton that is meant in the reports of the U-boat sinkings.

F. R. D.

GOVERNMENT SPECIFICATIONS

Manufacturers have had considerable trouble with the specifications furnished to them by some of the purchasing departments of the Government. There is a natural and commendable tendency on the part of the officers of the Ordnance Department to demand the best that can be produced. In their eagerness to obtain the best, however, specifications are often drawn that cannot be met commercially, and that unnecessarily increase the expense of the material. In some cases, however, the specifications are unreasonable, erroneous, and give evidence of carelessness or ignorance in their preparation. As an example may be cited the following specifications for a gun-metal. The government specifications read as follows: elastic limit, 54,800; tensile strength, 30,000; reduction of area, 30 per cent; elongation in two inches, 20 per cent.

The metal was to be composed of copper, from 87 to 89 per cent; tin, from 9 to 10.5 per cent; zinc, from 1.75 to 2.50 per cent; lead, 0.01 per cent.

To begin with, there is an obvious error in specifying a tensile strength below the elastic limit, and it is apparent that an error had been made in transposing these two items, it being evident that a tensile strength of 54,800 pounds per square inch and an elastic limit of 30,000 pounds per square inch were required. The company to whom the specifications had been submitted would not go ahead until the error had been corrected, and endeavored to submit them to the officer who had issued them. The sales manager of the company was sent to see him, but the officer refused to give him a hearing, stating that the specifications were not of his own making and that they would have to stand as issued.

Apart from the obvious error in giving the specifications, the values for the tensile strength and the elastic limit, even if transposed, were too high for the metal requested. The specifying of a percentage of 0.01 per cent of lead is also an evidence of poor judgment. After considerable delay, the Government finally accepted a gun-metal according to navy specifications, with a tensile strength of 30,000 pounds per square inch; an elastic limit of 15,000 pounds per square inch; and an elongation in two inches of 15 per cent.

In another case, the specifications called for a tensile strength of 65,000 pounds per square inch and an elastic limit of 50,000 pounds per square inch, and required the metal to be composed of from 56 to 57.5 per cent copper; 0.5 to 0.75 per cent tin; from 1.0 to 1.5 per cent iron; with a maximum of 0.5 per cent aluminum and 0.35 per cent manganese, the remainder being zinc.

After some delay, caused by the difficulty of proving to the government officials that these specifications could not be commercially met, the Government accepted a manganese bronze made to the standard navy specifications, with a tensile strength of 65,000 pounds per square inch and an elastic limit varying from 25,000 to 35,000 pounds per square inch.

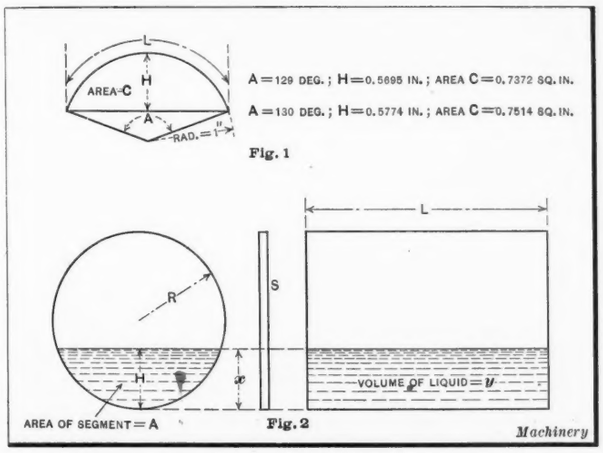
In a third instance, the specifications called for "Pc-2" navy phosphor-bronze, but specified a minimum tensile strength of 35,000 pounds per square inch with the following composition: copper, from 85.5 to 87.5 per cent; tin, from 10 to 11 per cent; zinc, from 2.0 to 2.5 per cent; lead, from 0.5 to 1.0 per cent; phosphorus, from 0.03 to 0.05 per cent; and with a maximum of 0.1 per cent of iron. These specifications for composition demand such close limits that it is not commercially practicable to produce a metal that will have these limits of analysis. The specifications accepted called for from 85 to 90 per cent copper; from 6 to 11 per cent tin; with a maximum of 1 per cent lead, 0.1 per cent iron, and 0.5 per cent phosphorus, the remainder being zinc.

Just why the Ordnance Department officer should try to improve upon the standard navy specifications cannot be explained, but much of the delay in the production of war materials is apparently due to the fact that people of limited experience, who have been taken into the Ordnance Department, are trying to make improvements upon the long-established specifications of the Navy Department which have proved satisfactory and which ought to be followed in order to prevent delay. We must all remember that we are at war; that we are in this war to *win, and to win quickly.*

FINDING CONTENTS OF CYLINDRICAL TANKS

BY LAY-OUT

On page 644 of the March number of MACHINERY, there is given a method of plotting a curve for finding the graduations of a scale used in measuring the number of gallons contained in cylindrical tanks, but the writer has found that, after he has computed the capacity and an easily found constant for any given tank, the distance of any graduation from the end of the scale for any given volume within the capacity of the tank can be quickly found by two settings of the slide-rule and reference to a table of the area of segments, like that found on pages 62 and 63 of MACHINERY'S HANDBOOK. One



Figs. 1 and 2. Finding Contents of Cylindrical Tanks

column H of this table gives the values for the height of the segment for different center angles and for unit radius; or, in other words, the ratio $\frac{\text{height of segment}}{\text{radius}}$. Another column gives the area of the segment in a circle of unit radius. The area of a similar segment of larger radius is this area multiplied by the given radius squared. The capacity of a tank of a given size is:

$$\text{Area of segment} \times \frac{\text{length of tank, in inches}}{231}$$

which is the capacity of a section one inch square and as long as the tank times the number of such sections contained by the tank.

Let L = length of tank, as shown in Fig. 2, in inches;
R = radius in inches;
H = height of segment for unit radius = $\frac{\text{height}}{R}$;
y = capacity for which graduation is to be found, in gallons, on scale S;
x = distance from graduation mark to nearest end of scale;
$U = \frac{L}{231}$ gallons in one inch square section;
C = corresponding area in table of unit radius segment;
A = segment of given radius.

As $H = \frac{\text{height}}{R} = \frac{x}{R}$, $x = HR$; also by the rule at the head of the table, $A = CR^2$. (Some handbooks give this in terms of diameter in which case H is one-half and C is one-quarter of the value given in MACHINERY'S HANDBOOK.) As $H = \frac{x}{R}$, $A = CR^2$, and $y = AU = CR^2U$, $C = \frac{y}{R^2U}$. Therefore, R^2U is a constant for any given tank.

Example—If a tank is 20 feet long and 6 feet in diameter, its total capacity is:

$$\frac{\pi \times (\text{radius, in inches})^2 \times \text{length, in inches}}{231} = \frac{3.1416 \times 36^2 \times 240}{231} = 4230$$

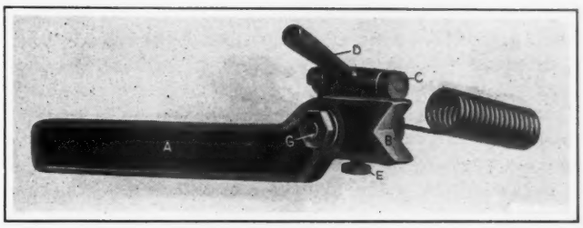
One-half of the capacity of this tank is, therefore, 2115 gallons. The constant R^2U for this tank is $36^2 \times \frac{240}{231} = 1346$. As $C = \frac{y}{R^2U}$, the corresponding area of unit radius and segment is $1000 \div 1346 = 0.743$. The table of corresponding areas given in MACHINERY'S HANDBOOK shows that this area is greater than the corresponding area of the segment of an angle of 129 degrees and less than that of the segment of an angle of 130 degrees. The illustration and values of A, H, and C shown in Fig. 1 are taken from the table in MACHINERY'S HANDBOOK. By interpolation in the table, the value of H is found to be 0.573. As $x = HR$, the graduation mark on the scale is $0.573 \times 36 = 20.628$ inches from the lower end.

In the case of 3000 gallons, the graduation will be marked from the top of the scale, because 3000 is more than one-half the capacity of the tank; therefore, y is $4230 - 3000 = 1230$, and $C = 1230 \div 1346 = 0.914$. By interpolation, the corresponding value of H is 0.665. Therefore, $x = 0.665 \times 36 = 23.94$ inches. The whole scale, of course, is equal in length to $2R$.

* * *

SPRING WINDER

In the accompanying illustration is shown a winding tool that is especially handy for winding heavy wire tension or compression springs. It may be used in the toolpost of any thread-cutting lathe that provides for the required pitch of the springs. The tool shank A is offset, so that it may come up close to the chuck, which holds the winding rod or mandrel. At one end B of the the tool shank is a V-jaw for any size of mandrel. The spring-wire tension box C contains two fiber



Spring Winding Tool

blocks which may be adjusted by means of the screw E and may be quickly tightened or released by the lever D. The tension box swivels on a stud G and will adjust itself automatically to any size mandrel. J. V.

* * *

ILLNESS IN INDUSTRY

In a paper read before the American Institute of Mining Engineers, by Thomas Darlington, secretary of the Welfare Committee of the American Iron and Steel Institute, it was stated that records show that the time lost by employes, through illness, ranges from four to ten times that lost as the result of industrial accidents; in fact, illness affects operating costs much more than is generally realized. Proper care of the health of employes would prevent much of this illness; and the cost of health supervision is not great. A comparison of costs in ninety-nine industrial establishments employing 495,544 men showed that it was about three-fourths of a cent per man a day. In the case of an iron and coal mining company that employed 11,000 men and furnished all the medical attention required by the employes and their families, the cost was less than four cents per man per day.

* * *

It has been estimated that of about 13,000,000 men employed in manufacturing plants in the United States, 6,200,000 are working on war supplies and subsidiary industries.

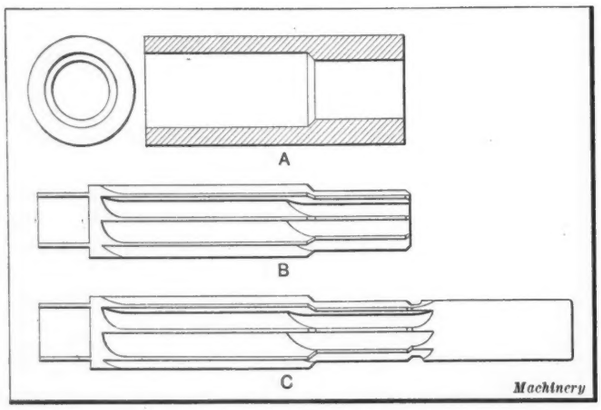


Fig. 1. Automobile Steering-knuckle Bushing and Reamers for machining Holes

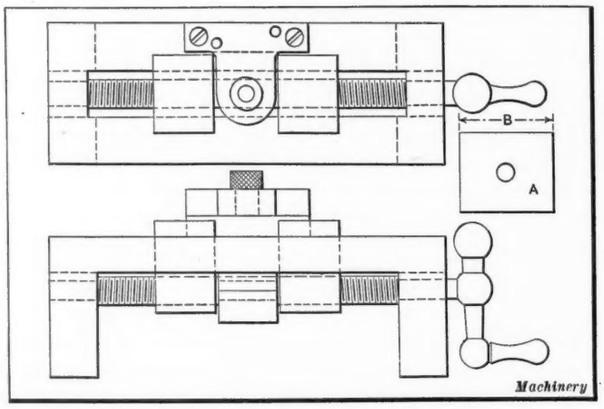


Fig. 2. Fixture for drilling and reaming Hole in Center of Work shown at A

RESULTS OF FAULTY TOOL DESIGNING

TOOLS AND FIXTURES THAT DID NOT WORK AND REASONS FOR FAILURE

BY F. B. JACOBS[1]

MODERN tool designing has been reduced to so exact a science that the drawings, or blueprints, that leave the drafting-room should impart full and explicit instructions to the toolmaking department. With expert tool designers, checkers, one or two assistant chiefs, and a chief draftsman, it would seem that none but perfect drawings should leave the tool designing department. This, however, is not always the case. In the vernacular of the shop man, "bulls" are often made with the result that tools made exactly according to the drawings furnished by the tool designing department are far from being efficient. The object of this article is to show a few simple mistakes in tool designing, the aggregate cost of which amounted to quite a sum. They were not all made in one shop nor in one locality, but have been found by the writer in various manufacturing centers.

At *A*, Fig. 1, is shown an automobile steering-knuckle bushing, in which both parts of the hole must be accurate as to size and at the same time concentric with each other. At *B* is shown the reamer that was made for this piece. As the large part of this reamer will begin to cut first, and as no means are provided to guide the smaller part of the reamer into the small part of the hole accurately, it is impossible for the tool to perform an accurate job. This reamer was expensive to construct, and it proved to be absolutely worthless.

The difficulty was overcome by providing the reamer with a pilot as shown at *C*. This makes the reamer more expensive, but its design is correct, and it is the style that should have been considered in the first place. In this case two reamers had to be designed and made to obtain one that proved satisfactory.

In Fig. 2 is shown a fixture for drilling and reaming a hole in the piece shown at *A*. Dimension *B* varies from 1 to 1½ inch, but it is necessary for the hole to be exactly in the center of the piece. The jig is equipped with a right- and left-hand screw, which actuates two jaws that grip the piece. If it were possible to produce a very accurate thread commercially, this principle might have worked all right, but it was soon found that the holes drilled were not central. To overcome this difficulty, the pieces are left a little large and finished by grinding on the fixture shown in Fig. 3. Two pieces *A* are held at one time and are forced upward against a stud *B* by wedges *C*. The wedge at the right bears at the center only, to insure the ground surface being parallel with the axis of the hole. The piece *A* is first ground on this side of the fixture and then transferred to the other side, where the other surface is ground. As the grinding of both sides of the piece is done at one setting of the grinding wheel, the hole must be in the center of the piece. The work is done on an ordinary surface grinder. This fixture gives excellent results.

Fig. 4 illustrates a bad blunder. This is an inserted-tooth reamer with a cast-iron body six inches in diameter, in which the high-speed steel blades are held by taper pins. As the edge of the cutter blade does not come to the center of the taper-pin hole, all the driving possible will not make the pins hold the blades, inasmuch as the action of setting up the pins only causes them to fit a little tighter in their taper holes without exerting any influence on the blades. The tool designer, in this case, excused himself by saying that he "didn't think."

The piece shown in Fig. 5 presents an interesting problem, as the surfaces *A* must be parallel with the holes. The original practice was to machine these surfaces and then drill and ream the piece in the jig shown in Fig. 6, in which the surfaces *A*, Fig. 5, are forced against the locating pads of the jig by means of two clamps. In theory, the jig is all right, but from a practical point of view it is all wrong. In the first place, it is almost impossible to machine the surfaces *A* so they will be absolutely accurate, and a slight error in parallelism, say 0.0015 inch, will have a tendency to cause the work to spring when clamped in the jig. As the holes are machined in this position, they will be out of line as soon as the jig clamps are released. Again, a slight amount of dirt on one of the locating pads will accomplish the same result, even though the piece is machined absolutely accurately.

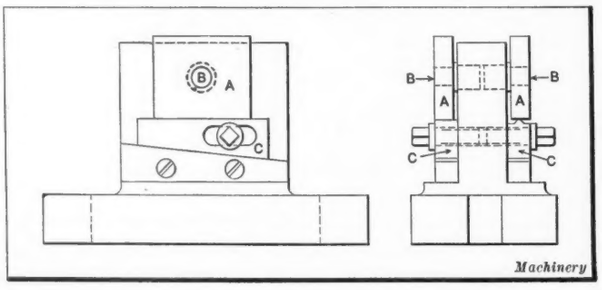


Fig. 3. Fixture for grinding Work shown in Fig. 2

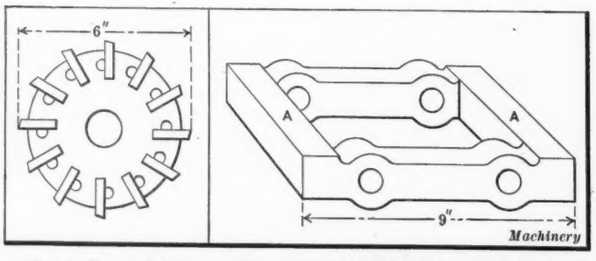


Fig. 4. Inserted-tooth Reamer

Fig. 5. Work in which Holes and Surfaces A must be Parallel

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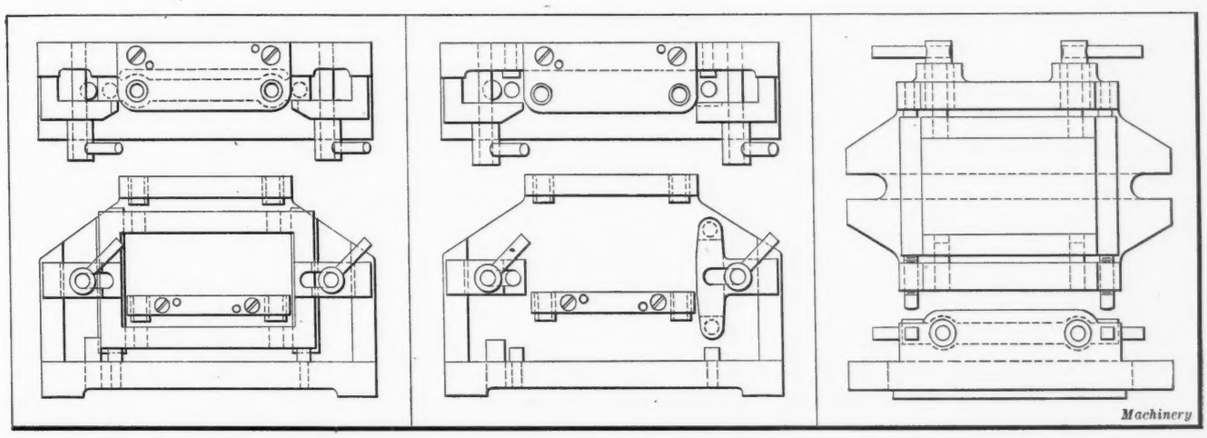


Fig. 6. Jig for drilling Work shown in Fig. 5 Fig. 7. Jig shown in Fig. 6 Redesigned Fig. 8. Grinding Fixture for Work shown in Fig. 5

When the fault was shown to the chief draftsman, he thought it would be a simple matter to remedy the difficulty by redesigning the jig as shown in Fig. 7. In this jig the three-point suspension principle is utilized, two clamps holding the work against three stops, and this produced holes that were in line, as far as that went; but still the problem of inaccurate machining of the surfaces *A*, Fig. 5, was not solved. Then the chief draftsman designed the grinding fixture shown in Fig. 8. After the holes were drilled and reamed in the jig shown in Fig. 7, the surfaces *A* were finish-ground in this fixture. It will be seen that the work is held in place by two aligning rods and two square-head set-screws, which force it against two stops. This fixture worked like a charm and accurately machined pieces were produced. Of course, it was necessary to remove a small amount from the location stops on the jig shown in Fig. 7 to compensate for the amount left for finishing by grinding.

At *A*, Fig. 9, is shown an automobile torque tube, on one end of which it is necessary to do some machine work after the flange *B* has been placed on the other end. This work is done on an engine lathe, and the piece is held in a fixture that is clamped on the faceplate while the tube revolves in the back-rest. In the particular case in question, the man that did this machining operation worked on a premium system, and he wanted a faceplate fixture that would save all the chucking time possible. So the fixture *C* was furnished, which, without a doubt, is very novel in design. Two straps *D* are held against the flange of the torque tube by heavy springs. The straps revolve on their studs over annular cam-shaped pieces *E*, the idea being that as the straps were struck with a lead hammer they would rotate around the stud and be raised out of contact with the work.

The operator placed his fixture in position on the faceplate of his lathe, set his back-rest, put a torque tube in place, and started to take a cut. As soon as the tool began to cut, its pressure forced the other end of the torque tube off the center, breaking the back-rest. The springs *F* were then removed and washers substituted.

The tools and fixtures described illustrate graphically the results of not thinking beforehand, and the only remedy the writer can offer for conditions producing such results is for the tool designing department to pay a little more attention to practical details. The tool-room foreman is a good man to consult occasionally. If he is a man of wide experience, he can, no doubt, point out many errors in design that the tool designing department frequently overlooks. Harmony between the tool designing department and the tool-room should prevail, because this "get together" spirit has proved to be productive of excellent results.

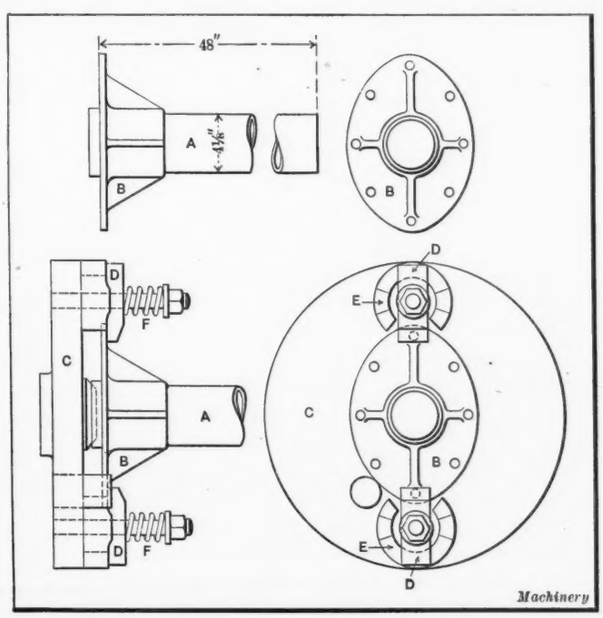


Fig. 9. Automobile Torque Tube and Fixture for machining One End

* * *

BRITISH PARLIAMENTARY COMMISSION REPORTS AGAINST METRIC SYSTEM

A final report has been presented to the British Parliament by the Committee on Commercial and Industrial Policy after the War, which has been at work for the past two years. The section of the report relating to weights and measures says: "We are unable to recommend the compulsory adoption of the metric system in this country. In our opinion, it is absolutely certain that the anticipated uniformity could not be obtained for a very long period, if ever. There is no unanimity even as to the theoretical merits of the metric system as compared with our own. The practical argument that its adoption is desirable in order to secure uniformity in the markets of the world has been shown to be unfounded. We are not satisfied by any evidence which has been brought before us that trade has actually been lost to this country owing to the fact that the use of the metric system is not compulsory. To attempt to make the use of the system universal and obligatory in this country would cause loss and confusion at a particularly inopportune moment, for the sake of distant and doubtful advantages. We are convinced that, instead of assisting in the reestablishment of British trade after the war, such a measure would seriously hamper it. The popular belief that the introduction of the metric system would render possible the immediate sweeping away of many complicated weights and measures is, in our opinion, wholly fallacious."

* * *

When work being ground is of such a nature as to cause the wheel to run out of true, frequent dressing will save the wheel rather than waste it. For example, a wheel that runs out 1/32 inch after one hour's grinding will run out 1/8 inch after two hours' grinding. If it is dressed after the first hour and again after the second hour, the amount wasted by dressing will be 1/16 inch, whereas after running two hours it is necessary to dress off 1/8 inch, or twice as much.

INTENSIVE PRODUCTION ON DRILLING MACHINES—2

DESIGN OF CUTTING TOOLS AND WORK-HOLDING FIXTURES FOR HANDLING TURRET LATHE WORK ON DRILLING MACHINES

BY EDWARD K. HAMMOND[1]

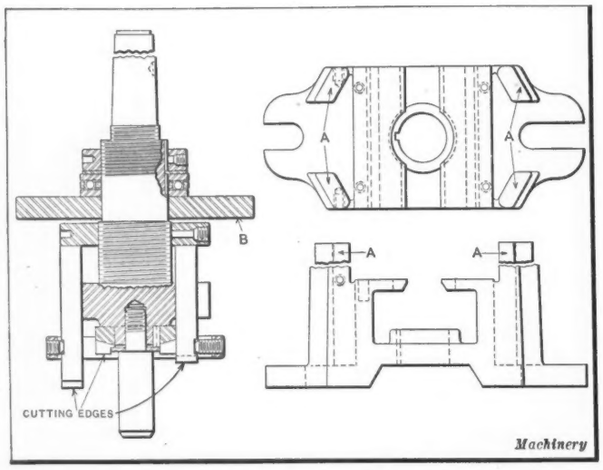


Fig. 6. Type of Tool and Work-holding Fixture used on Parts where Accuracy in tripping Feed is of Great Importance

IN the first installment of this article, information was given in regard to the organization of the drilling machine department and a description was presented of special equipments which were provided on the Baker Bros. high-duty drilling machines in order to adapt them for handling a wide range of work for the machining of which turret lathes would usually be considered necessary. In the present article, it is intended to describe the various special forms of cutting tools, jigs, and work-holding fixtures which are used on the machines, and to explain principles of tool design which have been responsible for making substantial increases in rates of production.

Design of Tools and Fixtures

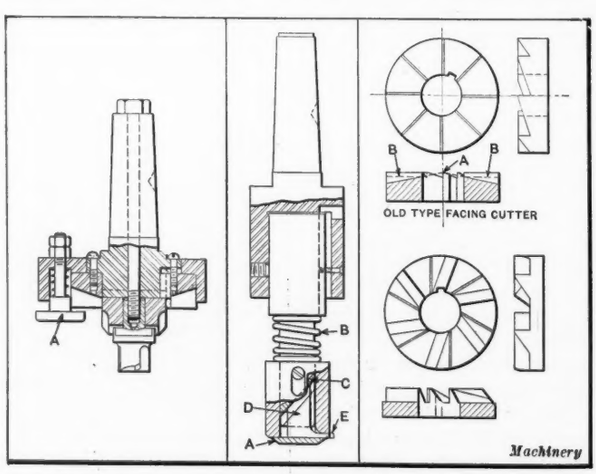
It will be apparent when looking over the schedule of operations presented in the first installment that advantage is frequently taken of the possibility of machining two or more surfaces on the work at a single operation. The form of each piece of work to be machined has been carefully studied, and after deciding the maximum number of surfaces that could be machined simultaneously the tool designers have taken up the problem of working out the form of tool best adapted to meet the requirements of this particular operation. Another point which will attract the attention of experienced machine shop men while looking over the illustrations of typical parts machined in the Bowser factory, will be the large number of parts which have several holes or holes and surfaces concentric with each other. In all cases it is desirable to maintain this concentricity within a reasonable degree of accuracy, and there are many cases where a very high degree of precision is important to obtain the desired alignment when these parts are assembled together. Here advantage is taken of the concentric holes or holes and surfaces on the work to provide for the use of piloted tools which may be depended upon to maintain the concentricity of different surfaces on the work from some hole which has already been machined.

In many cases it is also necessary to hold vertical dimensions on the work within close limits. Various means are provided on the tools for obtaining this result. In piece No. 2 in the table of operations (June installment) it is required to maintain the height *E* from finished face *B* to the upper side of the flange on the rough casting within 1/64 inch. The automatic tripping point for the feed of the drilling machine spindle is set as closely as possible, but to guard against lack of uniformity in the castings a button *A* is provided on the facing tool which comes down into contact with the casting that is being machined. This tool is shown in Fig. 7. Normally the power feed is tripped at the same time that this button engages the work. The drilling machine on which this operation is performed is set up without having the automatic return for the drill spindle in operation; and after the power feed has been tripped the operator looks at the button on the tool to see that it is down in contact with the work. Should it happen that this engagement has not been obtained, he feeds the spindle by hand before returning it and setting up a fresh piece of work on the machine.

How Accuracy in Tripping of Feed is Assured

In starting to describe special means provided in the design of tools to assure accuracy in tripping the feed mechanism, attention is called to the fact that Baker high-duty drilling machines are especially adapted for heavy work, and although the automatic trip for the feed mechanism may be safely relied upon to disengage the feed within 1/64 inch of the desired point, it is not safe to rely upon a much closer limit. As a matter of fact, this is quite close enough for many classes of work handled on the battery of Baker drilling machines used in the factory of S. F. Bowser & Co. At the same time, there are many classes of work where the maximum error must not exceed 0.005 inch, and in such cases the tools are designed to make sure that the work is held to at least this degree of accuracy. As shown in Fig. 6, it will be seen that the arrangement employed calls for a combination of work-holding fixture and cutting tool which work in conjunction with each other. On the fixture there are placed four posts *A* that are engaged by a flange *B* on the cutting tool. This fixture and tool are used for machining the gear shown in the fifth position in the table of operations. It is necessary to have the thickness of this gear 1.750 ± 0.005 inch, and to provide for obtaining this result the tools are so designed that collar *B* comes into engagement with the top of posts *A* when the cutters in the tool have reached the desired depth in the work.

To prevent binding, it will be seen that a ball thrust bearing is provided on the tool above the collar. The regular trip mechanism on the machine is depended upon to disengage the feed worm clutch at the desired point, but the arrangement of the tool and work-holding fixture makes it impossible for a slight lack of sensitiveness in the machine to prevent tripping to take place until the work has been machined beyond the minimum dimension which is called for. Those who have not experimented with the amount of spring which is possible to obtain in machine tools, naturally assume that the use of an arrangement of this kind would result in damage to the machine if the trip for the feed mechanism



Figs. 7, 8, and 9. Tool which assures Accuracy in tripping Feed, Design of Under-cutting Tool, and Old and Improved Types of Facing Cutters

[1]Associate Editor of MACHINERY.

failed to operate at the same time that collar *B* came into engagement with posts *A*. As a matter of fact, experiments have shown that it is quite practicable to obtain a spring of from 0.005 to 0.010 inch before any damage is done, and as a result, the provision made in designing the tools makes it impossible for the bits to cut into the work beyond the desired point. If the trip for the feed mechanism fails to function when this point has been reached, the bits are prevented from cutting further, and springing of the machine members takes place until the feed is disengaged.

Design for Under-cutting Tool

Where it is necessary to make an under-cut on the work, use may be profitably made of the type of tool shown in Fig. 8. This tool is used in making the under-cut in the "fill pipe cap" shown in the next to last position in the table of operations. The following is a brief explanation of the way in which this tool operates. Button *A* comes down into engagement with the side of the casting in which the under-cut is required. Further travel of the feed mechanism results in compressing spring *B* which, in turn, forces a cam *C* down into contact with the angular top of cutter *D*. When cam *C* engages cutter *D* further movement of the feed mechanism of the drill press results in forcing out the cutting edge *E* which is thus fed into the work. This is a simple and convenient arrangement for machining under-cuts on the drill press. Of course, it is understood that at the same time that cutting edge *E* is being fed into the work, the edge is rotating to machine the under-cut all the way around the piece.

Special Form of Facing Cutters

To provide for utilization of tool steel as far as possible, the tool designers have worked out a special form for facing cutters used on this battery of drilling machines. For the purpose of comparison, Fig. 9 shows the old type of facing cutter and the improved type of cutter which is now in use. Referring to this illustration, it will be seen that teeth of the old type of cutter have all of the lines diverging from a common point *A* at the center of the top surface of the cutter. In sharpening a cutter of this type, grinding may proceed until the teeth of the cutter are worn down to a point indicated by dotted lines *B*. When this point has been reached the cutter is considered worn out.

It will be apparent to anyone who gives this matter consideration that not over approximately 12½ per cent of the steel in the cutter has been used up when the teeth are ground down to line *B*. To overcome this obvious waste, an improved type of facing cutter was developed, in which it will be seen that the flutes are milled to a constant depth. This result was easily accomplished when the tool designer once decided to break away from established practice in grinding the teeth and flutes with all lines converging from a common point *A* to

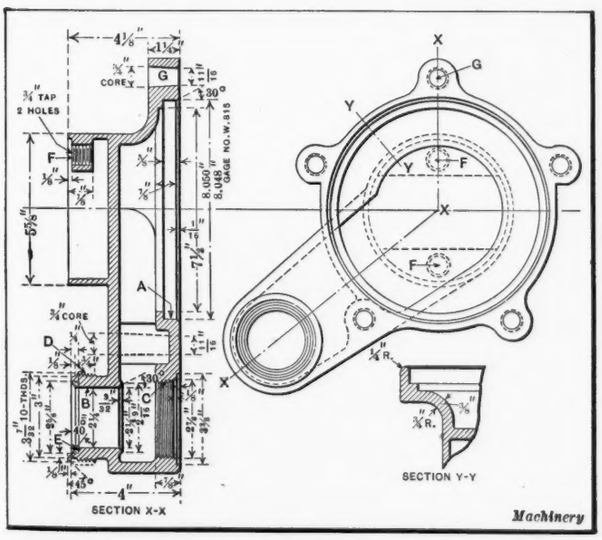


Fig. 10. Larger View of Cylinder Bottom shown in First Position in Tabulated Data on Machining Operations in the June Installment

which reference has already been made. In sharpening one of these improved cutters, it will be evident that the teeth can be ground right down to the bottom so that 50 per cent of the steel in the cutter is used up, i.e., four times as much service is obtained as from the old type of cutter. A further advantage of this improved facing cutter is that the cutting edges of the teeth are arranged tangent to a small circle

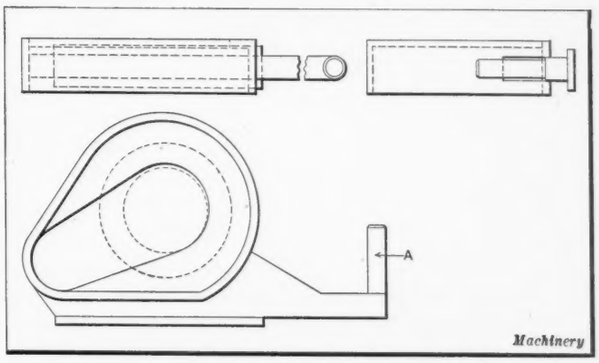


Fig. 11. Fixture used to hold Work while performing Disk-grinding Operation on Besly Double-spindle Machine

surrounding the center of the cutter instead of having them converge to this center. As a result, a shearing action is obtained which enables the tool to cut more freely than is the case where the cutting edges of the teeth are radial. Also, additional clearance for the chips is provided by having the flutes milled to a constant depth.

Special Features of Jigs and Fixtures

It is not within the scope of this article to enter into an exhaustive discussion of the jigs, fixtures and similar equipment provided for use in machining the great variety of parts that are handled on Baker drilling machines used by S. F. Bowser & Co. There are one or two points, however, which are of more or less general application, and these will be mentioned very briefly. For instance, there are many parts where simple drilling, boring, facing, and similar operations have to be performed. Here it is unnecessary to provide a jig or fixture for locating the work, but means must be provided for preventing the work from turning while the machining operation is in progress. For this purpose considerable use is made of what are known as slotted fixtures, one of which is shown on the first machine illustrated in Fig. 2 in the first installment of this article in the June number. Suppose a square or hex-shaped piece has to be machined; one of these slotted fixtures will be set up on the drill press table and then two rails will be slipped into slots in the fixture at such a distance apart that the work can just be dropped between them. This is only one of the many uses which is made of these slotted fixtures. In the illustration the fixture is shown set up with a work-holding device made out of boiler plate, that affords clearance for the tool after it has passed through the work.

In most cases the outstanding feature of the jig and fixture equipment is the extreme simplicity of its design. This is, of course, a point of cardinal importance where high production is aimed at, because the least unnecessary complication of equipment would result in a corresponding reduction in the speed of operation and rate at which parts could be set up and removed after machining. In many cases it has been found feasible to use standard three-jaw chucks where circular parts have no projections to prevent them from turning around under the spindle. Another feature, which is a result of the war-time cost of copper and zinc, is the provision of special trays around the fixture holding brass and bronze parts that are being machined. These trays catch all of the chips as fast as they are produced and enable them to be collected without loss—an important saving at the present time.

Tools and Fixtures for Machining Cylinder Bottoms

Lack of space obviously makes it impossible to enter into a complete discussion of all the cutting tools, jigs and fixtures used for machining the parts for which the operations and

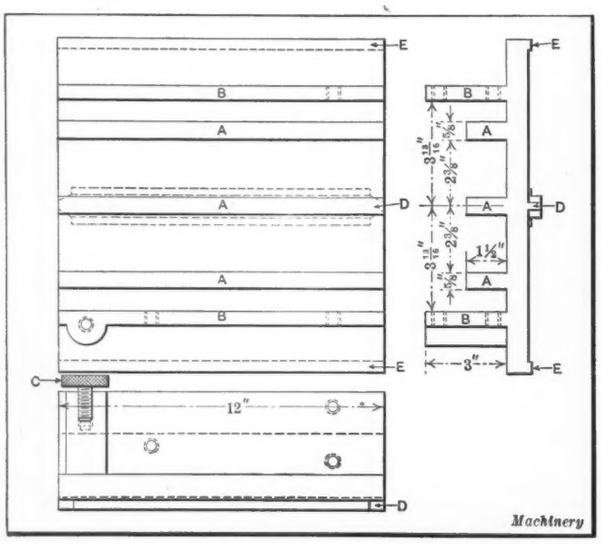


Fig. 12. Fixture in which Work is held while boring and reaming Hole A

rates of production have been tabulated. At the same time, the practice of S. F. Bowser & Co.'s factory engineer in designing tools and work-holding fixtures is unusually interesting, and with the view of giving a general idea of this practice, a complete description is given of all cutting tools, jigs and fixtures used for machining the cylinder bottom which is shown first in the tabulated information on machining operations, and also in Fig. 10.

The first operation consists of disk-grinding the top and bottom of this piece of work, and a Besly double-spindle machine is used for the purpose. The work-holding fixture employed is shown in Fig. 11, and will be seen to consist of a socket in which the work is held in an edgewise position with the top and bottom extending out from the fixture so that they may be engaged by the two disk wheels. This fixture has a handle *A* by which it is pushed back and forth between the disk wheels on the machine, and these wheels are relied upon to hold the work in the fixture.

The second and third operations consist of rough-boring and reaming hole *A*. In both cases the work is held in the fixture shown in Fig. 12, and the cutting tools are shown in Figs. 13 and 14. For both boring and reaming, the speed is 25 R.P.M., and the feed is 0.018 inch per revolution. Referring to the tool shown in Fig. 13, it will be seen that the boring is done by bits *A*, while the function of bits *B* is merely to cut a 30-degree chamfer at the top of the hole. Fine-pitch screws *C* furnish means for making accurate adjustment of the position of the chamfering cutters. The tool for reaming this hole requires no special description.

The work-holding fixture, Figs. 12 and 12A, used for these two operations is of simple design, three rails *A* supporting the work while a rail *B* at each side of the fixture prevents the work from rotating. Very little time is required to slide work into such a fixture. It will be apparent from the dimensions that the flange on the work has considerable overhang at one end, and as this flange is at a higher level than the top of the side rails *B*, it would be unsupported. To overcome this difficulty, and at the same time to allow for

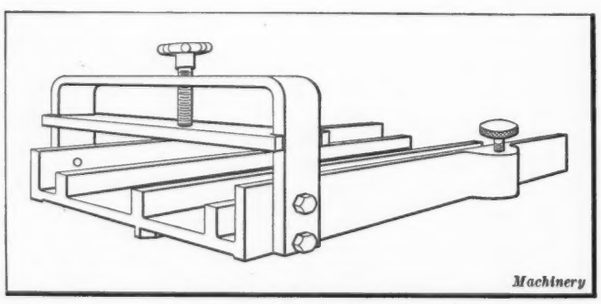
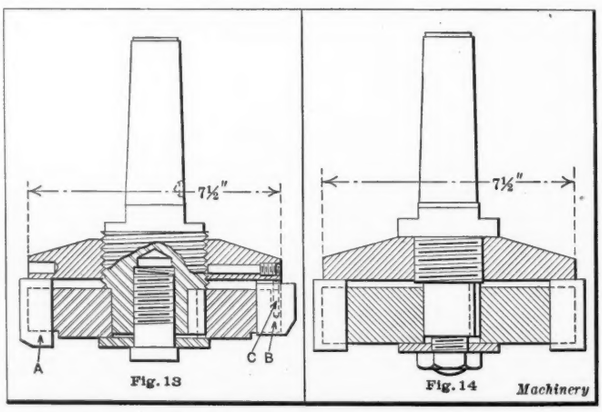


Fig. 12A. Perspective View of Boring and Reaming Fixture, showing Arrangement of Clamping Mechanism

slight variations in the castings, a knurled-headed screw *C* is provided on the fixture. When the operator sets a casting in place he adjusts the position of this screw so that it comes up against the under side of the flange, thus supporting the work ready for the machining operation. Particular attention is called to the tongue *D* and strips *E* on the under side of the fixture. This is a standard construction on practically all work-holding fixtures, the purpose being to provide a "floating" fixture which is enabled to align itself properly with the drill spindle. All fixtures of this type rest on a standard baseplate (not shown in the illustration) which is not bolted down to the table of the machine. The upper side of this plate has a groove to receive tongue *D* and is machined to form bearings for strips *E*. On its under side this plate has a tongue running at right angles to the groove in its upper surface, and this tongue fits into the T-slot on the drilling machine table. As a result, the fixture floats in so far as the spindle of the drilling machine is concerned, although it is held in such a way that rotation of the fixture is impossible.

The fourth operation consists of boring holes *B* and *C* and cutting a 30-degree chamfer at the top of hole *B*. For this purpose the same work-holding fixture is employed that was used on the two preceding operations. The cutting tool is shown in Fig. 16, and will be seen to consist of cutters *A* and *B* for boring holes *B* and *C*, respectively. The operation is performed at a speed of 100 revolutions per minute, and a feed of 0.010 inch per revolution.

The fifth operation consists of finish-boring hole *B*, facing the surface at the top of the valve seat in this hole, and cham-



Figs. 13 and 14. Tools used for boring and reaming Hole A in Work shown in Fig. 10

fering and facing top of hole *C*, for which the fixture used is shown in Fig. 15. It will be seen that to all intents and purposes the fixture is the same as that used for performing the preceding operations, except that the portion of the fixture under the part of the work that is being machined is furnished with solid metal surfaces shown at *A*, instead of simply having the work supported by a narrow rail. The reason for this construction is that, while the previous type of fixture is plenty good enough for the performance of roughing operations, for taking the finishing cut it is possible for the work to be cocked sufficiently out of alignment to produce an appreciable error. It is to guard against the possibility of such a contingency that the present type of fixture is employed. Attention is called to the fact that this fixture is used for the performance of several other operations, and the openings at *B* and *C* with solid metal surfaces surrounding them have no special significance in connection with the present operation. The cutter used for taking this finishing cut is shown in Fig. 17. It will be seen that cutter *A* reams hole *B*, while cutter *B* faces the top of this hole. Chamfering and counterboring the top of hole *C* is done by cutter *C*, while facing the top of this hole is done by cutter *D*. Attention is called to the fact that cutters *C* and *D* are piloted in hole *C* to assure accurate alignment. This operation is performed at a speed of 100 revolutions per minute, and a feed of 0.014 inch per revolution.

The sixth operation consists of tapping hole *C*, for which purpose a No. 9 tap, made by the Manufacturers' Equipment

Co., of Chicago, is employed, this tap being furnished with a special pilot shown in Fig. 18, which runs in hole *B*. This pilot is shown at *A* in Fig. 18, and is held in place in the tap by a draw-bolt *B*. Above the collar on this draw-bolt the design is similar to the regular bolt used on the standard tap, but the thin extension *B* below the collar is provided to reach down and hold pilot *A* in place. The fixture used for performing this operation is the same as that used on the second, third and fourth operations. The work is done at a speed of 25 revolutions per minute.

The seventh operation consists of finishing the valve seat. The work is set on the bed of the machine without using a fixture, and the tool used is shown in Fig. 19. The valve seat cutter is shown at *A*, and attention is called to the fact that a collar *B* is provided on the tool which enables the seating tool to cut in to exactly the proper depth. This operation is performed at a speed of 100 revolutions per minute with hand feed.

After the valve has been seated, the eighth operation is to turn the outside of union *D*, face the top of this union, and counterbore for the brass insert *E*. The work-holding fixture used for this purpose is shown in Fig. 20; and it will be seen to be practically identical with the fixture used for performing the second, third and fourth operations. It consists of three rails *A* to support the work and two side rails *B* to prevent the work from rotating. The cutting tool used for this purpose is shown in Fig. 21, from which it will be seen that three bits *A* provide for turning the outside of the union, three cutters *B* for counterboring for the brass insert *E*, and tool *C* for facing the top of the union. It will be seen that the design

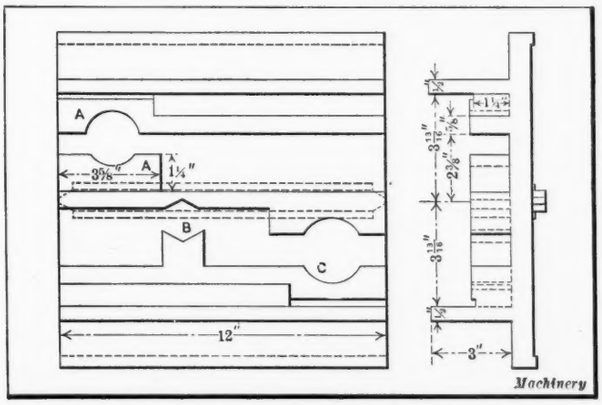
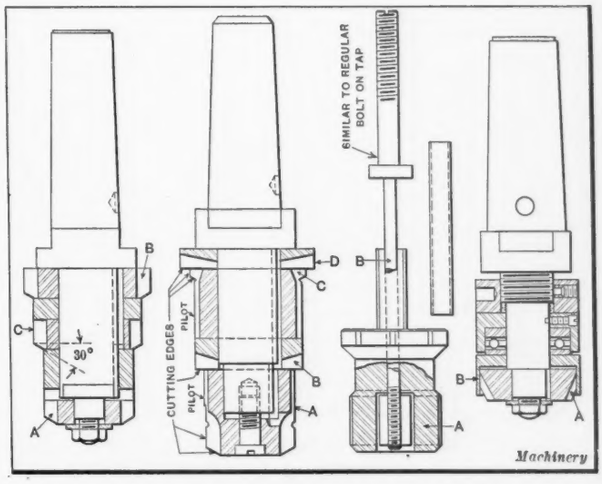


Fig. 15. Work-holding Fixture in which Casting is held for finish-boring Holes B and C

of this tool is worked out in such a way that two lock-nuts *D* support the bits *A* and *B* from the top and provide accurate means of adjusting them in the desired vertical position.

At the same time, the bits are furnished radial support by means of set-screws *E* carried in a collar surrounding the lower part of the tool. This is a somewhat old tool, and recently the design of this type of tool has been considerably modified to provide better radial support for the cutters. In designing tools of this type it is now the practice to bring the collar down within about ¼ inch of the cutting edge of the bits, instead of having the bits overhang approximately 1¼ inch. In this way there is far better support and the possibility of their springing away from the work is very materially reduced. Some tool designers will be inclined to say that the amount of spring which could possibly occur in a tool of the type shown in Fig. 21, is so small that the change in design is scarcely worth while. Granting that this is the case, the Bowser tool designers did not feel satisfied with any form of construction which left the possibility for an error which there was any way to overcome. The speed at which this operation is conducted is 72 revolutions per minute, with a feed of 0.012 inch per revolution.

The ninth operation consists of reaming the bore for the brass insert *E*. The same fixture is used as for the preceding operation, and the tool employed is shown in Fig. 22. This will be seen to consist of a simple reaming cutter *A* mounted on a suitable shank. The operation is performed at a speed of 100 revolutions per minute, with hand feed.



Figs. 16 to 19. Tools for rough-boring Holes B and C, finish-boring Holes B and C, Special Pilot for Tap for Hole C, and Valve-seating Tool for Top of Hole B

After reaming the hole for the brass insert, the tenth operation is to thread the outside of union *D*, which is done with a threading die. The same fixture is used as for the two preceding operations, and the work is done at a speed of 25 revolutions per minute. After threading, the work is ready for the eleventh operation, which consists of pressing the brass insert into place. This is done with a portable arbor press, which is brought up to the gang drills at such times as it is required for service. The arbor press is mounted on a skid, so that it can be carried on an elevating truck; it is motor-driven and connected to the power circuit arranged on this battery of drilling machines.

The twelfth operation consists of cutting the valve seat in brass insert *E* in the union. The work is held in the same fixture as for the preceding operation, and the tool used is shown in Fig. 23. It will be seen that this is a simple angular mill *A* mounted on a suitable shank. A guard *B* is placed around the cutter to provide for the operator's safety. The operation is performed at a speed of 180 revolutions per minute, and a feed of 0.010 inch per revolution.

The thirteenth operation consists of drilling two holes *F*. The same work-holding fixture is used as in the preceding operation, and the holes are located by means of a jig shown in Fig. 24. Pin *A* is dropped into the cored hole *G* on the work and locating pins *B* enter the rectangular shaped hole in the work, shown by dotted lines between the holes *F* which are to be drilled. When handwheel *C* is turned so that tapered block *D* is drawn up between the heads of pins *B*, these pins are forced outward, which results in clamping the jig firmly in place over the work. Hardened steel bushings, through which the holes are drilled, are located in holes *E* in the jig. The drilling operation is performed at a speed of 280 R.P.M., with a feed of 0.010 inch per revolution. After these holes have been drilled, the jig is removed from the work, which is left in position in the fixture ready for the performance of the fourteenth operation. This consists of tapping the holes *F*. This tapping operation is performed at a speed of 72 R.P.M.

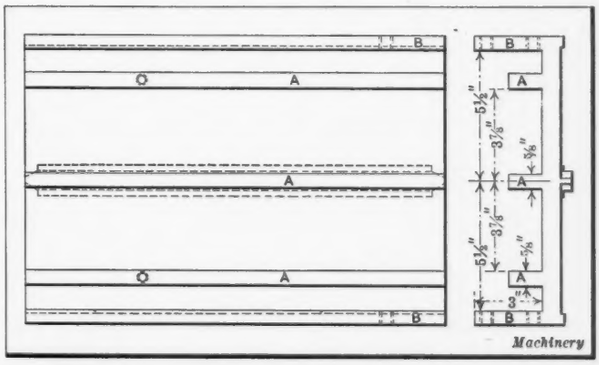


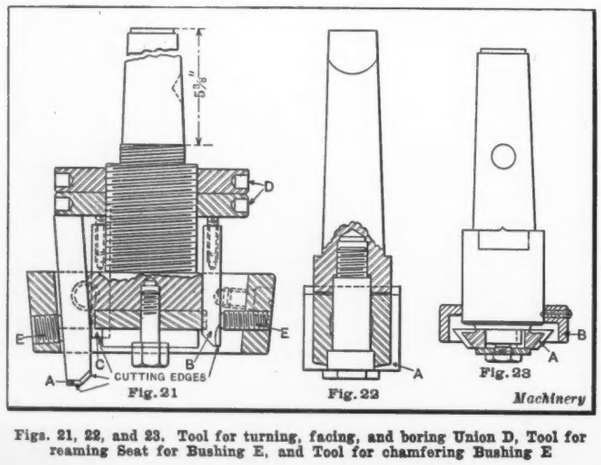
Fig. 20. Fixture used for holding Work while turning and facing Union D

Of these fourteen operations, it will be recalled that Operation 1 is done on a disk grinder, while Operation 11 consists of pressing a brass bushing into place in the work, a portable arbor press being used for this purpose. As a result, there are twelve operations that are performed on the Baker drilling machines, and these are divided up into three groups of four operations each. In order to have the relative amount of time taken by different operations work out to the best possible advantage, the following grouping was decided upon: Operations 2, 3, 13, and 14 are performed on a group of four machines; Operations 4, 5, 6, and 7 are next performed on this group of four machines at the second setting; and Operations 8, 9, 10, and 12 are performed at the third setting of these four machines.

It will be recalled that in the first installment attention was directed to the fact that an endeavor is always made to select groups of four operations in such a way that all four machines of the group may be kept as constantly employed as possible. The grouping together of Operations 2, 3, 13 and 14 is a good example of this kind. Operation 13 calls for drilling two holes *F*, one at a time, and Operation 14 consists of tapping these holes one at a time. To provide for performing these two double operations without keeping other machines idle, they are grouped with Operations 2 and 3, which consist of boring and reaming the large hole *A*, and take as much time as the double operations of drilling and tapping two holes *F*, one at a time. In handling his battery of four machines, the operator goes from Operation 2 to Operation 3, then to Operation 13, where he starts drilling one hole, then to Operation 14, where he starts tapping one hole and waits until this operation is completed, the time being only a few seconds. He then starts the tap in the second hole for Operation 14, after which he starts the drill for the second hole in Operation 13. After this, he goes back to Operation 2 to start work on a fresh piece, and this order of procedure is followed continuously, with the result that all machines are kept constantly employed. In conclusion, it may be mentioned that only one group of four machines is working on the same piece at a time. After the first four operations have been performed on all pieces, this same group of four machines starts on the next four operations; and when these have been completed, the final group of four operations is performed on this set of machines. It would not do to have twelve machines out of a battery of twenty-eight working on one part.

Concerning Rates of Production

As most of the work handled on this battery of high-duty drilling machines is of a character where an extremely high degree of accuracy is not required, the rates of production obtained in performing machining operations become a matter of unusual importance. A good idea of the actual output in machining various parts which could be handled with a shop equipment of this character will be gathered from a study of the machining operations and rates of production which are tabulated in connection with this article. It will at once be apparent to the experienced production engineer that these rates of output are very satisfactory. But a man who is considering the problem of selecting equipment for machining a given line of work which might be handled on drilling machines will naturally ask himself the question, "Is there no better way in which I could machine these parts?" An answer to this question is found in the experience of S. F. Bowser & Co. during the past two years. This firm's shops have been so rushed with work that a practice has been made of arranging with outside concerns to machine work on a contract basis. In many cases the figures submitted for machining parts which are ordinarily handled in the drilling machine department have been so far above the company's own production costs that a good deal of hesitation was felt about letting contracts to these bidders. Investigations which were conducted, however, went to show that the margin of profit made on the work by these outside concerns was not at all excessive, and as most of the bids obtained from outside machine shops were considerably above the cost of producing work on drilling machines—after deducting a reasonable margin of profit—it is fair to conclude that these shops based their bids upon the use of equipment which was unable to compete with the highly specialized tools and methods which have been described in this article.



Figs. 21, 22, and 23. Tool for turning, facing, and boring Union D, Tool for reaming Seat for Bushing E, and Tool for chamfering Bushing E

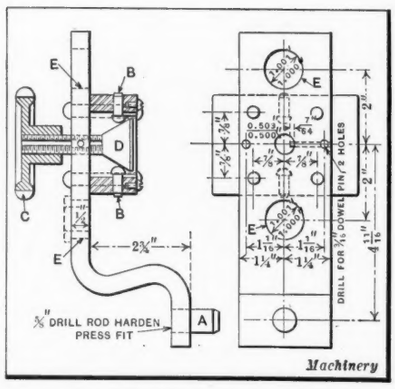


Fig. 24. Jig used for drilling Holes F

* * *

DRAFTING-ROOM SPECIFICATIONS FOR COMPRESSION SPRINGS

BY C. C. SPREEN[1]

Many mistakes in drawing and figuring springs may be avoided if the following rules are observed in the drafting-room. The standard sizes of wire and wire gages that are standards for the different metals used in the making of springs should be specified on drawings as follows:

Washburn & Moen gage, now known as American Steel & Wire Co. gage, for steel and iron wire and for tempered steel wire springs.

American Steel & Wire Co. music wire gage for music wire springs.

Brown & Sharpe gage for brass, phosphor-bronze, and German silver wire springs.

Name inside diameter of springs if used over a rod, and state size of rod.

Name outside diameter of springs if used in a hole, and state size of hole.

If used over a rod and in a hole, give dimensions of both rod and hole.

State free lengths of springs, pitch of coils, or number of coils per inch.

The style of ends should be specified as open ends, not ground; open ends, ground; closed ends, not ground; and closed ends, ground. If the ends should be closed and ground perfectly square with the axis, the specifications should read accordingly.

If the springs should be scale tested, state length to which they should be compressed, under a specified number of pounds pressure.

State variation allowable over and under the number of pounds pressure specified.

Note if plain or japanned, etc., finish is desired.

* * *

To close large cracks and small holes in brickwork, fill the opening with asbestos, and cover this with a cement made in the proportion of 10 pounds of asphalt, 10 pounds of magnesia-asbestos, 10 pounds portland cement, and 1/2 gallon benzine. Heat the asphalt until it is fluid, remove from the fire, and mix in the benzine; then add, while stirring, the cement and magnesia-asbestos, which have been previously mixed and heated to 300 degrees F. If the surface to be sealed is subject to high temperature, increase the proportion of cement and magnesia.

[1]Address: 208 W. Court St., Flint, Mich.

LETTERS ON PRACTICAL SUBJECTS

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REAR SIGHT OF AIR RIFLE

The accompanying illustrations show the rear sight of an air gun and the three-stage follow-die for making it in one operation. In Fig. 1, *A* is the finished sight and *B* is the end of a strip which shows the first two stages. The strip of

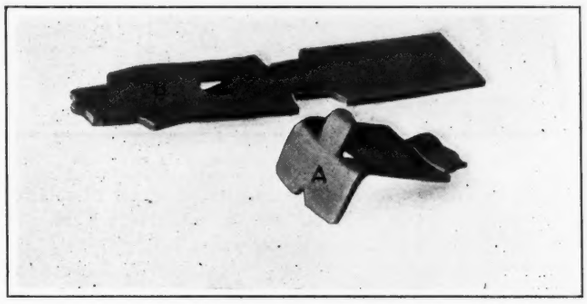


Fig. 1. Rear Sight of Air Rifle

metal from which these sights are made is 0.59 inch wide. Fig. 2 is a cross-section on the line *XY*, Fig. 6, through the notching punches and dies and shows the stripper and guide, as well as outlines of parts of the shoe and the punch-holder. Fig. 3 is a cross-section, on the line *UV*, through the parting die and shows the parting punch *I*, the pilot *H*, and the forming die *E* and punch *J*. Fig. 4 is a plan of the top of the punch-holder. Fig. 5 is a projection through the die and the punch, and Fig. 6 shows the plan of the die; the notching dies are shown at *A;* the piercing punch at *B;* the parting die at *C;* the tongue-bending punch at *D;* the forming die at *E;* the notching punches at *F;* the piercing die at *G;* the pilot at *H;* the parting and bending punch at *I;* the forming punch at *J;* the stripping pins at *K;* the holding pad at *L;* the main die-plate at *M;* the supplemental die-plate at *N;* the first stop at *O;* and the second stop at *P*.

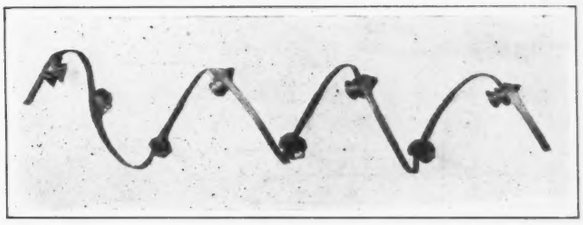
The die for cutting the tongue is in the punch-holder at *G*, and the punch *B* is below. The tongue is forced out of the die by a pad actuated by a spring in the punch-holder, and is stripped from the punch by the pins *K*. The notching punches *F* are much wider than the notches cut out and have heels, which center the strip and back against the dies to resist side thrust. The pilot *H* keeps the strip lined up.

The main forming die *E* slides in the plate *M* and rests on a spring pad that is actuated by a heavy square-section spring *R;* above, the pad *L* is backed by a lighter spring. The pad *L* holds the piece to the die *E* while it is being cut off by the punch *I;* the spring *R* is then compressed, allowing *E* to descend. As the punch *D* is stationary in the plate *N*, it forces up the tongue into the recess in the punch *J*. At the end of the stroke the die *E* bottoms on the plate *N*, giving the piece its final form.

De Kalb, Ill. W. B. GREENLEAF

PECULIAR DRILL CHIP FORMATION

The accompanying illustration shows a curious chip formation obtained when drilling tool steel with a 3/4-inch drill in a turret lathe. The drill was ground as accurately as possible, and the steel, as far as could be judged, was not piped or seamed. Nevertheless, one-half of the chip rolled up into



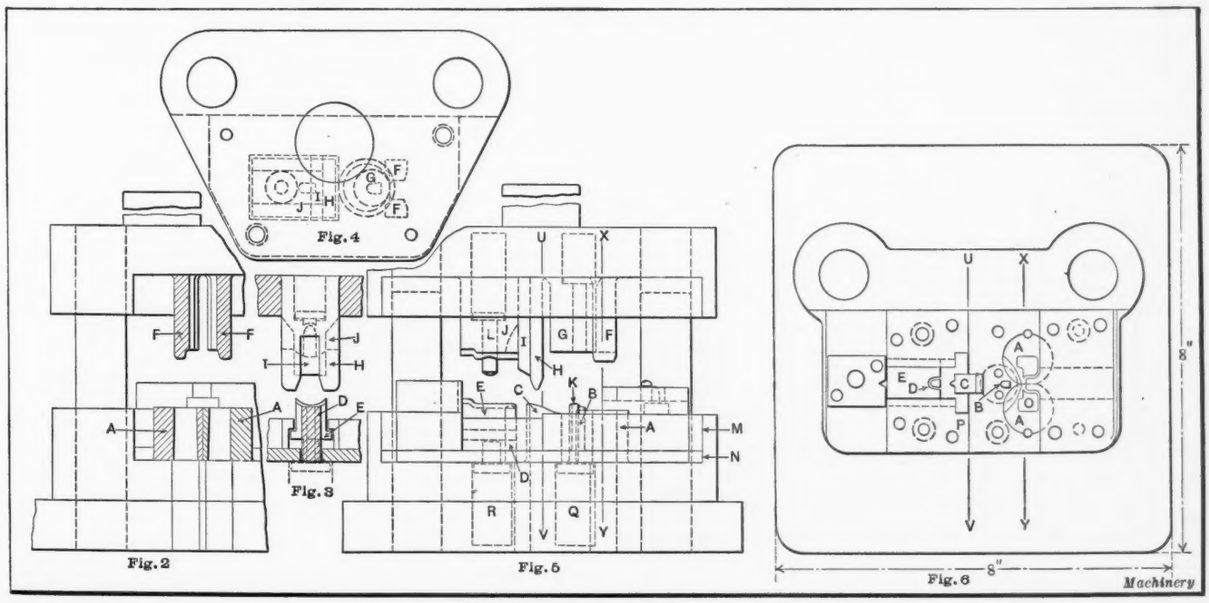
Peculiar Drill Chip Formation

small curls at regular intervals, while the other half presents an unbroken helix. The cause for this peculiar chip formation is somewhat of a puzzle. L.

ACCIDENTS ON MONDAY

In reply to a query as to the proportion of accidents on Monday as compared with those on other days of the week, owing to Saturday and Sunday drinking, the Brown & Sharpe Mfg. Co., which has paid especial attention to the gathering of accident statistics, writes:

> We are interested in the point raised, regarding the drink question and its relation to accidents. Our accidents last year were equal on Monday and Tuesday, with a larger



Figs. 2 to 6. Die for making Rear Sight of Air Rifle shown in Fig. 1

percentage of the more serious ones coming on Tuesday. This, however, would not indicate that your general principle as laid down was wrong, because Monday night is pay-night with us, and this might encourage such habits in the case of certain employes as would lead to a greater number of accidents on Tuesday. The accidents for these two days are somewhat above the average for the week; but on the whole our employes are of a temperate class, and we do not think this trouble is exaggerated, as in many shops.

New York City — ROBERT GRIMSHAW

SIMPLE TOOLS FOR MAKING COIL SPRINGS

A great many manufacturers using coil springs are not in a position to make them as cheaply as firms making a specialty of this business, but it often becomes necessary, due to delayed delivery, etc., for them to make these springs in their own plant. The tools here illustrated and described are simple, low in cost, and produce springs suitable for practically any class of service.

The winding mandrel shown at *A*, Fig. 1, has a clamp for the end of the wire that is simple but positive and from which it is possible to remove the spring quickly. The diameter of the mandrel is determined by trial before making the clamp attachment, starting with a size that is amply large and turning it down until the spring winds to the correct size, using a

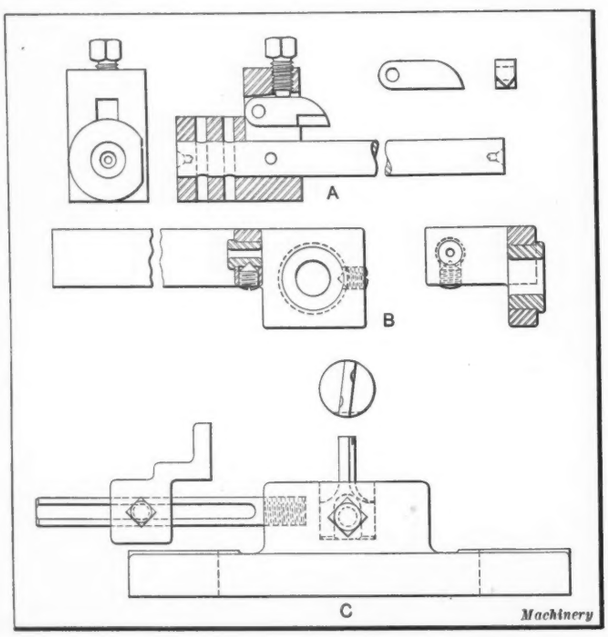


Fig. 1. Mandrel and Guide for winding Spring, and Cutting-off Jig

temporary clamp to hold the end of the wire. A mandrel 20 inches long over-all is satisfactory for springs of ordinary size. The combination steadyrest and wire guide *B* has interchangeable bushings for the mandrel and the wire.

The cutting-off jig *C* is used in a power press and has a chisel-pointed tool in the ram. An adjustable stop is provided to gage the length, which is determined by trial; a record of this length is kept. The shape of the anvil is important, and an anvil will probably be required for every different spring, due to variations in diameter, space between coils, etc. Notches in the flat part of the anvil provide clearance for the coils.

The grinding mandrel shown at *A*, Fig. 2, clamps the spring on its end by a collet, which is expanded as the taper end of the internal rod is drawn back by the wing-nut. This collet has four longitudinal slots, as shown, and is of a length which will clear the grinding wheel about 1/16 inch when the wire is of the ordinary size. The thickness of the steel washer shown is one-half the difference between the cut-off length and the finished length of the spring. It is placed on the mandrel back of the spring when grinding the second end so as to insure the same amount being ground off each end. The heat generated in grinding tends to close the end coil somewhat, making a more continuous flat bearing on the end. The rest shown at *B* serves as a holder for the pilot part of the mandrel

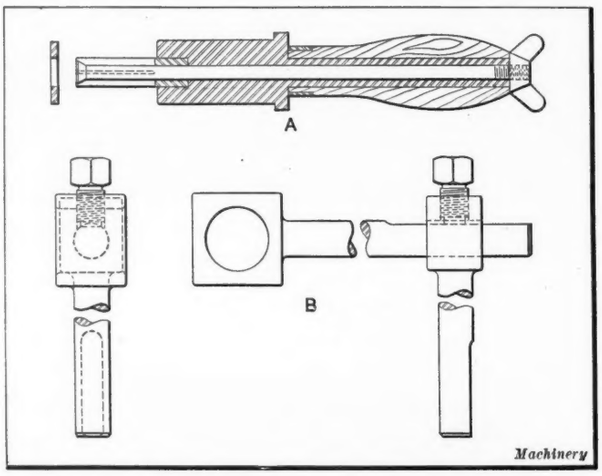


Fig. 2. Mandrel and Rest for grinding Ends of Springs

and also as a stop. By making the pilot diameter of sufficient size, one rest can be used for springs of various sizes. The grinding is done on the side of the wheel.

Dubuque, Iowa — CHESTER W. HATHAWAY

MEASURING TAPERS AND RING GAGES

A great many uses have been found for the common roller of a roller bearing in the tool-room. Because of the high grade of steel used and the accuracy with which the roller is manufactured, it is valuable in measuring tapers, gages, and in many other difficult measuring propositions. Fig. 1 shows an example of the use of the rollers in measuring a taper. The work *M* has been turned to a given taper per inch and is to be tested for accuracy; *A*, *B* and *C* are Johansson test pieces of 1, 2 and 3 inches height, respectively, while *D* and *E* are rollers of equal, known dimensions. Gage *M* is placed on a surface plate as shown, and the blocks *A* set up to the taper; the rollers *D* and *E* are then placed on the blocks in contact with the taper, and the measurement *F* is taken. The blocks *B* are then substituted for *A* and another measurement *G* is taken, which should equal the measurement of *F* plus the given taper per inch. For further accuracy the blocks *C* may be substituted and the same procedure followed by taking measurement *H*.

Fig. 2 shows an example of the use of the rollers for measuring a ring gage. The gage is placed, flat side down, on a surface plate, and two rollers *A* and *B*, of known dimensions, are placed as shown. The distance between the rollers is built up by means of the Johansson test pieces *C*, *D* and *E*, leaving *E* for the final piece so that a measurement to four decimal places can be obtained. The total dimension of *A*, *B*, *C*, *D* and *E* will equal *X*. This operation should be tried in several places to locate high or low spots and insure accuracy. The rollers may also be used by the toolmaker for accurately locating work in jigs and fixtures, for setting a piece of work, on which a surface is to be planed or milled at an exact angle, for testing a square, measuring dovetails, and numerous other cases that are continually met with by a toolmaker.

Westboro, Ottawa, Canada — FRED V. BALL

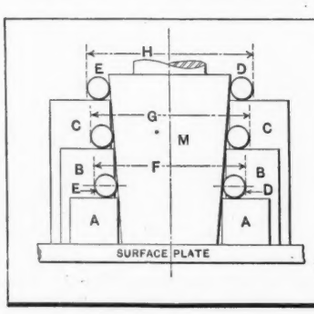


Fig. 1. Measuring Taper with Blocks and Rollers

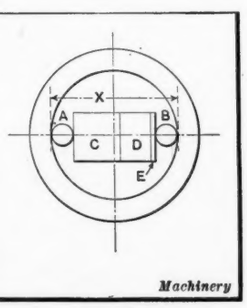
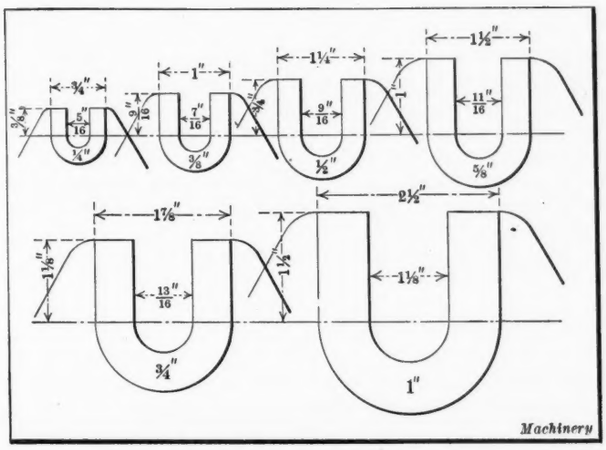


Fig. 2. Measuring Ring Gage with Blocks and Rollers



Standard Proportions of U-lugs

STANDARD SIZES OF U-LUGS

In the accompanying illustration are shown the standard sizes of U-lugs for jigs and fixtures. These lugs are for bolt sizes from one-fourth to one inch and are used for fastening the jigs or fixtures to machinery beds, tables, etc.

Flint, Mich. C. C. SPREEN

ALUMINUM IN BRASS CASTINGS

The use of aluminum in brass castings becomes quite an obsession with some foundry foremen, and they entirely ignore the purpose of the aluminum, adding to every pot of molten brass from two to eight ounces. Apart from any deoxidation which is effected, the usual result is to give a bright color to the castings; assuming that they are to be used as they leave the molds, their appearance is very desirable. If, however, the articles are to be dipped and lacquered, or if they are to be either silver- or nickel-plated, the aluminum is fatal to good work, as its rapid oxidation prevents the regular action of the acid or plating baths. Therefore, dry polishing is the only available method of finishing brass castings containing aluminum.

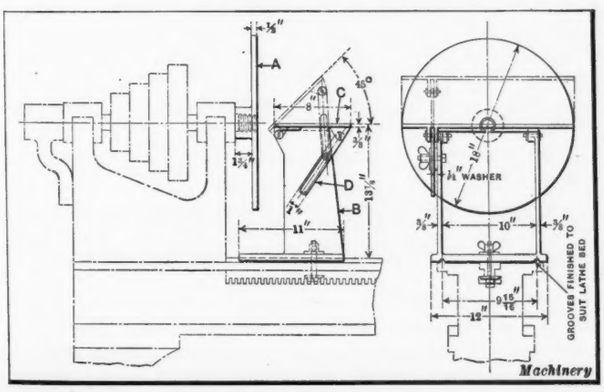
Liverpool, England MARK MEREDITH

LATHE DISK SANDER

The economic value of sandpaper is becoming more apparent every day, and one of its most useful applications is in the patternmakers' art. Five minutes of sanding on a disk will frequently accomplish more than an hour would in any other way. It smooths up end grain and sands out saw marks. A large disk is more desirable than a small one, because the sandpaper farthest from the center does most of the work.

The illustration shows a side and end elevation of a disk sander attachment for use on a wood-working lathe, which can be quickly removed from the lathe and stored away when not in use. The sander consists of a disk *A*, stand *B*, plate *C*, arm *D*, pins and bolts. The disk *A* is screwed on the lathe spindle and is machined to receive the sandpaper, which is cemented to the face of the disk. The stand *B* is machined to fit the lathe bed, and is held in place by a bolt and wing-nut. The plate *C* is pivoted to the stand *B* at the front, and has a lug at the rear in which an arm *D* is secured by a pin. The plate *C* can be raised from a horizontal position to an inclination of 45 degrees by means of the arm *D*. The arm is held in different positions by a bolt and wing-nut.

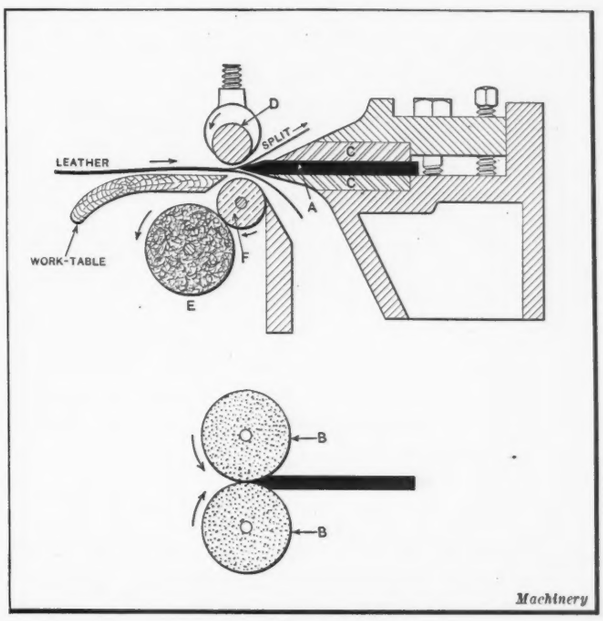
Chester, Pa. GEORGE W. CHILDS



Lathe Disk Sander

MACHINE FOR SPLITTING HIDE

On account of the extensive use of leather in automobiles there has been so great an increase in the demand for leather that it is necessary to split the hides to a greater extent than formerly. For most commercial purposes a hide is cut up into several thin sheets called "splits," and it is only for such uses as belting and sole leather that the natural thickness of the hide is retained. The outside or hair side of a hide is the best and most expensive of all the sheets into which it may be separated. The other sheets are known as "doped" splits; in the manufacturing process these are treated to give them the properties of the outside piece as near as possible and an artificial grain that makes them all look alike.



Section of Hide-splitting Machine

There are features of interest about every special machine, but the one to be described is especially noteworthy when one considers that a hide ready for splitting is as soft as paper, that it is not symmetrical, has projecting ends, and measures eight to nine feet one way, and that it is required to cut these splits so that they are gaged within the 0.002 inch limit. The machine used for quantity work is of the continuous knife or belt knife type, and might be likened to a band saw with a long dimension horizontal instead of vertical, and a wide blade without teeth.

The accompanying illustration represents a section through the machine, showing the blade or knife with its guiding jaws and the rollers for feeding and sizing the leather. The knife is 1/16 inch thick, and when new, 3 inches wide. It is kept in a state of almost razor-like sharpness by a pair of emery wheels *B* which are continuously running and act on the knife on its lower or return travel. The jaws *C* which guide the knife weigh altogether nearly a ton; they are faced with hardened steel wearing surfaces, which are ground straight after fastening on the jaw castings. This makes a rigid assembly, which holds the knife under perfect control and forms a working basis of known accuracy. Above the knife is the gage roll *D*. The split passes out between it and the knife, the required thickness being obtained by adjusting the bearings of the roll up or down. This roll is set by using tissue-paper feelers between it and the knife; then when

parallel, a standard feeler is used to set the roller to the correct height for a certain thickness of leather. Because of its length the roll would sag in the middle, thus causing a split to be thin at this point, so two three-quarter bearings are placed so as to support it, this being done by screw adjustment when setting the roller parallel.

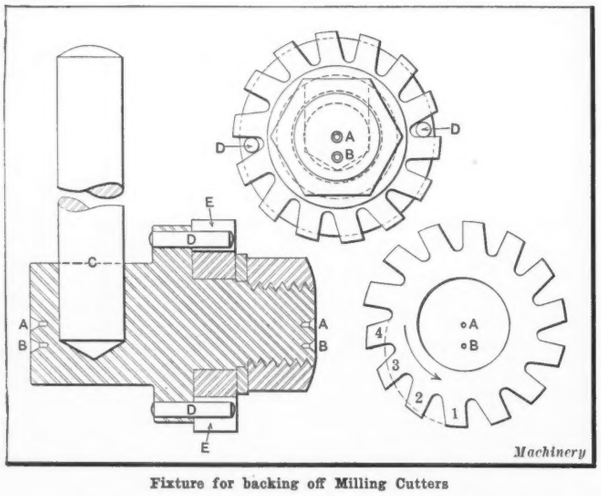
Below the knife are two other rollers forming the drive, provided with a self-adjusting feature which takes care of any inequalities in the hide. These rollers need only occasional resetting. The large roller *E* is made from a gum composition of such resiliency that the rollers *F* above embed themselves in it when a heavy section is passing through the machine. The rollers *F* are not continuous, but consist of a series of short brass rollers mounted on a rod, forming a flexible driving roller for the under side of the hide no matter how uneven it may be. The gum roller is power-driven, transmitting power to the brass roller, which is maintained in position by a back-plate. This machine splits one hundred hides a day into four hundred parts, and to do that it requires four men to feed and handle the hides.

Middletown, N. Y. DONALD A. HAMPSON

FIXTURE FOR BACKING OFF MILLING CUTTERS IN THE LATHE

An efficient and cheap device for backing off small milling cutters is shown in the accompanying illustration. It consists principally of a steel arbor that has two sets of centers. One set *A* is used when the arbor is turned to the required shape; the other set *B* is placed 1/4 inch to one side and is used for backing off the cutter. When backing off, the arbor is turned by the handle *C* that is fitted into it as shown; this handle should be placed at a convenient angle for the operator. Two driving pins *D* fit between the teeth of the cutter *E*, which is held in place by a nut and washer; one pin, however, will be found strong enough for this purpose.

In the end view of the cutter, the dotted arc recedes toward the center as it passes from tooth 1 to tooth 4, indicating the degrees of clearance produced on these teeth. If more or less clearance is required, the cutter is moved around on the arbor to the required position. It is better to mount the cutter on



Fixture for backing off Milling Cutters

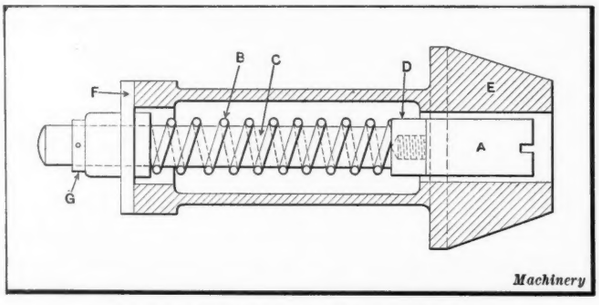
the arbor so that it may be moved in the direction indicated by the arrow. The lathe tool is fed in after each cut in the backing-off process, and as each tooth is finished the cutter is moved around and the driving pin placed in the next slot.

New York City E. J. HIGGINS

INTERCHANGEABLE EJECTOR FOR HAND SCREW MACHINES

In the accompanying illustration is shown an ejector for hand screw machines that can be used in any size collet by simply changing the knock-out pin *A*. With this ejector, the operator does not have to stop to remove the completed work; when he releases the collet, the reaction of spring *B* causes the knock-out pin *A* to throw the work into a box or pan placed beneath the machine. This ejector will be found especially useful on work that must be set a given distance in the collet. When setting such work without an attachment that will keep the work in contact with the stop in the turret, the work sometimes slips away from the stop and must be removed and reset.

The knock-out pin *A* is made of tool steel and should be 1/16 inch smaller than the diameter of the collet. It is hardened and drawn to a straw color. A slot is cut in the front end for a screwdriver; the other end is turned down to about ¼ inch diameter and threaded. This end screws into a hole in the plunger *C*, which is made by turning down a piece of 9/16-inch, round, cold-drawn steel to ⅜ inch, leaving a ¼-inch shoulder *D*. The length of this plunger depends on the style of collet *E* with which it will be used. The plunger *C* is actuated by a helical spring *B*, which is made of 1/16-inch



Interchangeable Ejector for Hand Screw Machine

spring steel, is 9/16 inch in diameter, and has four or five turns to the inch. One end of this spring bears against the shoulder *D*, and the other end bears against a bossed flange or center plate *F*, through which the plunger *C* passes. This plate is made from a piece of steel 1/16 inch larger than the inside diameter of the spindle in the machine and is about 1 inch long. After a ⅜-inch hole is reamed through it, the piece is placed on an arbor and the bosses turned to ¾ inch in diameter. The flange is turned 0.003 inch smaller than the inside diameter of the spindle and is ⅛ inch wide; care must be taken to make its sides parallel with the ⅜-inch reamed hole. Plate *F* is held in place on plunger *C* by a collar *G*, which is fastened to the plunger by a cotter-pin. When milling the hole for the cotter-pin the spring *B* must not be compressed, but should fit between the shoulder *D* of the plunger and the center plate *F* without any play.

Aurora, Ill. JOHN J. BORKENHAGEN

INVENTIONS AND INVENTORS

The article "Inventions and Inventors" in the April number of MACHINERY was not, in the writer's opinion, in the least overdrawn with reference to the lack of consideration and fair play that is generally extended to inventors. The writer knows of at least one concern that makes a rule of hiring its designers and inventors only upon condition that they agree in writing to assign any patents or inventions that they may perfect while on the payroll in consideration of the payment of the sum of $1. Such a policy cannot possibly create an incentive to apply inventive ability to the best advantage, and the effect of this practice is to discourage the naturally creative mind, causing a lack of interest in the work. The writer knows of a case where even the sum of $1 was not forthcoming as provided for in the contract.

Hopedale, Mass. F. R. DANIELS

FUEL VALUE OF POWDERED COAL

In the article entitled "Solution of the Fuel Problem," on page 680 of the April number of MACHINERY, there are given the costs and methods of pulverizing the coal, but nothing is said of the comparative values of different fuels. Based on a plant using 54,000 cubic feet of natural gas an hour, the fuel costs per hour are: 54,000 cubic feet of natural gas at 35 cents per 1000 cubic feet, $18.90; 4000 pounds of coal at $3 a ton, $6:

400 gallons of fuel oil at 8 cents a gallon, $32; producer gas, $10.

As the operating costs, including the cost of fuel, are: Oil fuel, $34.59; producer gas, $14.73; and powdered coal, $8.41, the saving per hour of operation effected by the use of powdered coal as a fuel instead of natural gas is $10.49; instead of fuel oil, $26.18; and instead of producer gas, $6.32. At these prices there is obtained, for one cent, 64,210 British thermal units from powdered coal; 36,660 British thermal units from producer gas; 15,614 from fuel oil; and 28,571 from natural gas. This shows clearly that powdered coal is easily the cheapest fuel.

New York City

W. O. RENKIN,
Manager, Engineering Dept.,
Quigley Furnace Specialties Co., Inc.

RECORD OF HEAT-TREATMENT OF TOOLS

In the daily routine of toolmaking and diemaking, it is frequently necessary to repair work that was made, perhaps, the previous year. If the foreman and the man who made the

CHART FOR RECORDING HEAT-TREATMENT OF STEEL

	Name of Steel	Name of Steel	Name of Steel
Identification letter	A	B	C
Heat, degrees F.	1360	2200	1400
Quench	In oil	Oil or air blast	Water

Machinery

work have left, no one knows the steel used nor the treatment given. As a result, though the repairs may be made in an excellent manner, the inspection, after hardening, may show that the work is warped, twisted, or perhaps cracked in various places and so is worthless. Nowadays, when there are various kinds of steel on the market, the tool department must be systematized the same as other departments. In many plants there is a tool-room in the different departments, each under the supervision of the foreman of the department, who designs the tools, giving verbal instructions to the men, or, if one is at hand, using a similar tool in place of a blueprint, but who makes no record for future reference. Such a record, however, can be easily and quickly made by using a chart like that here shown. On this chart is given all the kinds of steel used in the tool-room, and beneath each is placed a designating letter and the proper heat-treatment for that steel. Then, after a tool is made, the letter is stamped upon it before it is hardened and tempered.

East Rutherford, N. J. GEORGE F. KUHNE

SAVING TIME IN THE DRAWING-ROOM

In many drafting-rooms it is not uncommon to see draftsmen making sketches on the back of discarded blueprints, letters, calendars, and other papers that happen to have one blank side. This practice may seem economical in view of the present high cost of paper, but undoubtedly there is often a great deal of time lost by the careless manner in which these papers are handled; this lost time would more than pay for better paper. The paper need not be of a very good quality, but the one thing that should be borne in mind is, that these sketches are valuable data and should be kept the same as a letter, drawing or other record. The writer recalls a number of instances when rough and greasy sketches, which were made in the shop and carefully filed away, were the deciding factors in questions brought up at a later date.

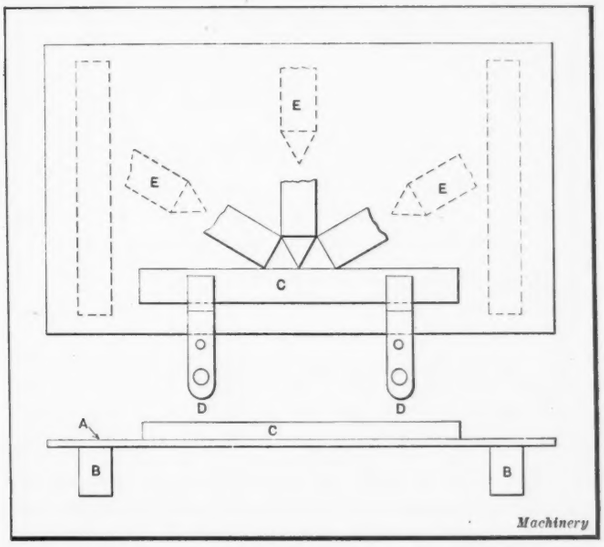
The writer uses a loose-leaf binder, taking sheets 7 by 9 inches in size. The binder is filled with blank sheets already punched, and whenever it is necessary to go into the shop to make sketches, a few sheets are taken from the binder and then filed in their proper place in the binder after the sketches are made. The binder is not only used for sketches, but may be subdivided with index tabs for filing other records, such as calculations, etc. The matter of making calculations is another source of much lost time in the drawing-room. When calculations are required, a great many draftsmen use the same system as in making sketches, namely, to use the first piece of paper that happens to be at hand, and after the problem has been solved the only record of it that remains is in the draftsman's mind. As a result, when the drawing is checked and the checker's calculations do not tally with the draftsman's, the latter has to do the work all over again. Had the calculations been filed, they could have been given to the checker to compare with his calculations, thus saving much of the draftsman's time.

Making pencil erasings on vellum paper is not an easy matter, as the lightest line seems to penetrate, and even with the greatest care in erasing, a smeared appearance results, but if before the drawing is started, magnesium carbonate is rubbed on the paper with a piece of cloth or felt, erasing becomes comparatively easy. Small blocks of magnesium carbonate can be purchased at any drug store.

Indianapolis, Ind. HARRY W. DAVIS

CHECKING 60-DEGREE POINTS FOR GAGING THREAD ANGLES

While employed as an inspector, the writer was asked to check some 60-degree points that had to be made absolutely correct. As he did not think the sine bar would give accurate enough results, for it is difficult to slide the indicator across the work with any degree of accuracy, he used the device shown in the accompanying illustration, which worked very satisfactorily. It consists of a sheet of glass *A* mounted upon two parallels *B* and supporting a third parallel *C*, which is held firmly in position by two clamps *D*. By placing a sheet of white paper under the glass *A* and then sliding the 60-degree points *E* into the position shown by the full lines, any rays of light that may pass between the points because of their inaccuracy is easily seen, it being assumed that the two points on the sides are known to be accurate. If none of the points are known to be accurate, the accuracy can be determined by interchanging points until three are found that are correct.



Method of checking 60-degree Points for gaging Thread Angles

Two of the points that have been found to be accurate can be used as masters for checking all others, which may be placed in the center.

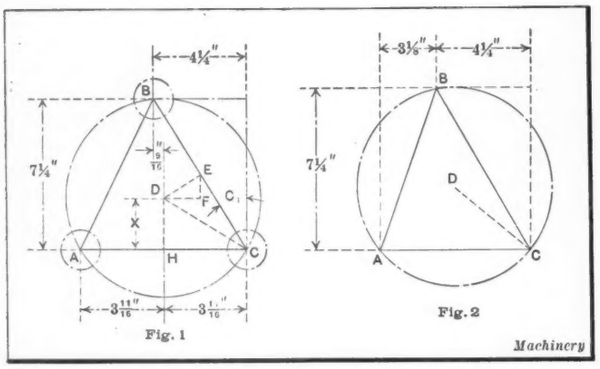
Cos Cob, Conn. CHARLES W. CARVETTE

PROBLEM IN TRIGONOMETRY

Two additional solutions of the problem in trigonometry, which appeared in the November number of MACHINERY, may be of interest. It is desired to calculate the center distance of a gear and three pinions, arranged as shown in the illustrations. In Fig. 1:

$$BC = \sqrt{4.25^2 + 7.25^2} = 8.4038 \text{ inches}$$

$$\text{Tan } C_1 = \frac{4.25}{7.25} = 0.58621 = 30 \text{ deg. } 22 \text{ min. } 46 \text{ sec.}$$



Figs. 1 and 2. Problem in Trigonometry

$$ACB = 90 \text{ deg.} - 30 \text{ deg. } 22 \text{ min. } 46 \text{ sec.}$$

$$ACB = 59 \text{ deg. } 37 \text{ min. } 14 \text{ sec.} = DEF$$

$$EC = \frac{BC}{2} = 4.202 \text{ inches}$$

$$DF = \frac{4.25}{2} - 9/16 = 1\ 9/16 \text{ inch}$$

$$DE = \frac{DF}{\sin DEF} = 1.8112 \text{ inch}$$

$$DC = \sqrt{DE + EC} = 4.576 \text{ inches}$$

$$X = DH$$

$$DH = \sqrt{DC^2 - CH^2}$$

$$DH = \sqrt{4.576^2 - 3.6875^2}$$

$$DH = 2.710 \text{ inches}$$

In Fig. 2:

$$BC = \sqrt{4.25^2 + 7.25^2} = 8.4038 \text{ inches}$$

$$AB = \sqrt{3.125^2 + 7.25^2} = 7.894 \text{ inches}$$

By geometry, in any inscribed triangle, the product of any two sides is equal to the product of the altitude upon the third side by the diameter of the circumscribing circle; therefore,

$$7.25 \times \text{diameter} = 8.4038 \times 7.894 = 66.3396 \text{ inches}$$

$$\text{Diameter} = 2DC = \frac{66.3396}{7.25} = 9.1503 \text{ inches}$$

$$DC = 4.5756 \text{ inches}$$

F. R. Daniels

USE FOR OLD FILES

The old-fashioned way of blowing chips and dust out of bottomed holes in castings or forgings with the blowpipe might well be discarded. By means of a magnetized old rat-tail file one can clean out the hole without filling the eyes or the atmosphere with dust.

New Haven, Conn. Eric Lee

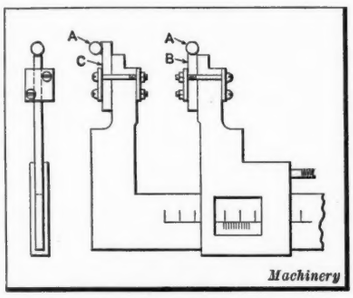
SPECIAL TAPER BORING TOOL

The special taper boring tool shown in the accompanying illustration is designed for use on milling or drilling machines. The piece *A* is made from machine steel and is packhardened. The tapered portion at *B* fits the taper in the machine spindle in which it is to be used, while the tapered portion *C* is made to fit the taper in the work to be finish-bored. The feed-screw *D* which feeds the tool *E* is squared at the end so that an offset socket wrench may be used to make a quick return of tool *E*. Feed-screw *D* is driven by star-wheel *F* through the spur gears *G* and *H*. The cap-plate *I* holds the feed-screw in place. The writer has used this tool on boring dividing heads, and found it exact where the limits of accuracy required were ± 0.001 inch. This tool can be made by any shop at a low cost.

Worcester, Mass. H. F. Clifford

ATTACHING BALL CONTACT POINTS TO A BEAM CALIPER

A method of attaching ball contact points to a beam caliper that is a little different from that shown on page 836 of the May number of Machinery is shown in the accompanying illustration. In this case, a 24-inch vernier caliper was used to measure from groove to groove and from grooves to a concave surface, and the attachment proved very satisfactory. The balls *A*, the size of which vary with the work, are soldered to the pieces *B* and *C*, which are held in place by clamps and bolts. When the piece *C* is used as shown, the caliper will measure from a concave surface to a groove; to measure from groove to groove, two pieces like that illustrated at *B* are employed.



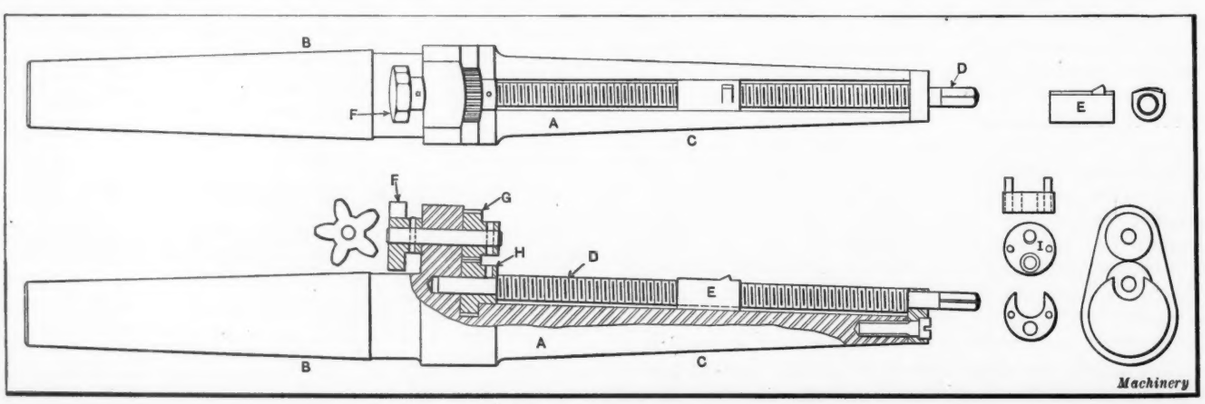
Method of attaching Ball Contact Points to a Beam Caliper

Wilkinsburg, Pa. William S. Rowell

WOMEN IN THE DRAFTING-ROOM

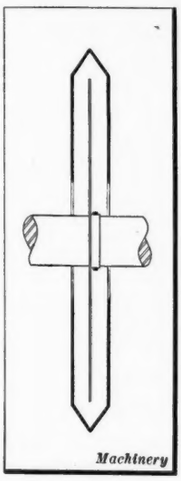
One of the remarkable developments of the war is the showing made by women in mechanical work. The May number of Machinery, page 799, tells of the women tracers at the Reed-Prentice plant, and, among other things, speaks of their speed and accuracy; women, however, made good in somewhat similar work twenty-five years ago when the International Correspondence Schools began to train them to correct and make drawings for the students, and found that they were remarkably suited to the work. Starting on the simpler geometric drawings and working to the more complicated ones, in a few months the women become so proficient that they can draw and letter extremely well. While the writer was a fair draftsman when he started a course with these schools eighteen years ago, he was forced to admit that their corrections were very fair and to the point. When a drawing came back corrected by L. McAndrews, he did not know it was Laura McAndrews until he was at the schools at a time that a rival institution was trying to discredit them in the courts by alleging misrepresentation in using women teachers for mechanical subjects.

Middletown, N. Y. Donald A. Hampson



Special Taper Boring Tool

SHOP AND DRAFTING-ROOM KINKS



Device for returning Leaking Oil to Reservoir

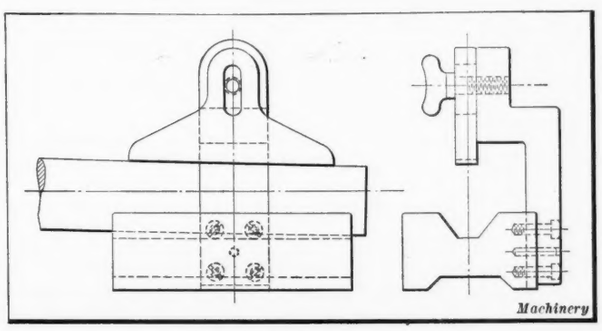
REMEDY FOR OIL-THROWING SHAFT

A short line of shafting and pulleys caused considerable inconvenience and loss of oil, because the lubricant would leak out of the bearing boxes and travel along the shaft until it encountered one of the pulleys, where it would come in contact with the belt or be thrown down into the room. The device illustrated was designed to remedy this. Since the oil was being thrown off by centrifugal force, a disk of galvanized tin, eighteen inches in diameter, was mounted on the shaft close to the bearings, and the oil traveled along the shaft until it reached the disk, when it was carried toward the edge of the disk and was thrown into a trough by centrifugal force, from which it was drained into an oil-can and was again ready for use.

Philadelphia, Pa. W. A. LAILER

DEVICE FOR FITTING TAPERS

The accompanying illustration shows a simple device for fitting tapers that the writer has found useful when making taper arbors or spindles to fit different makes of machines. In most cases it is impossible to bring the machine into the tool-



Simple Device for fitting Tapers

room to have a new arbor or spindle fitted in, but by setting this device to the taper of the old arbor or spindle, it is easy to fit the new taper without wasting time running back and forth to the machine to try the new piece.

South Manchester, Conn. ALFRED PILLING

A GOOD CONCRETE FLOOR

A good concrete floor may be made by mixing thoroughly one part of good hydraulic cement, two of sand and three of gravel, and spreading the mixture evenly over the floor, with a gentle slope in two directions toward one corner, where there is a drain. All around the wall, while the cement is still soft, a gutter of semicircular cross-section should be made by pressing a smooth round log into the mass; this makes a desirable curved imprint. Of course, the gutter must have the same slope toward the outlet as the cellar floor.

New York City ROBERT GRIMSHAW

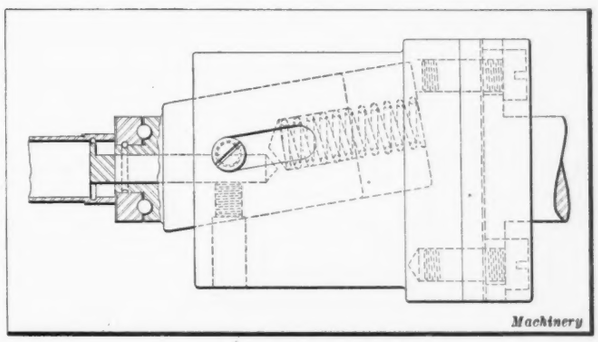
EMERY CLOTH HOLDER

In a tool-crib known to the writer emery cloth is bought in rolls ten inches in diameter and one and one-half inch wide. The roll is mounted on a revolving holder that is similar to those used for strips of theater tickets. In most cases it is a small piece of emery cloth that is required; but the old custom was to ask for a whole sheet, tear off a strip, and leave the rest on the bench, eventually to find its way, unused, into the dirt can. With the new method of having various grades on roll-holders near the tool-crib window, time and emery cloth are saved, as a mechanic can see and get what he needs.

New York City E. J. HIGGINS

RECESSING TOOL

The accompanying illustration shows a universal recessing tool. This tool was designed for automatic screw machine work, but it can be used on hand screw machines, lathes, and in drill presses when the work is made fast to the table of the



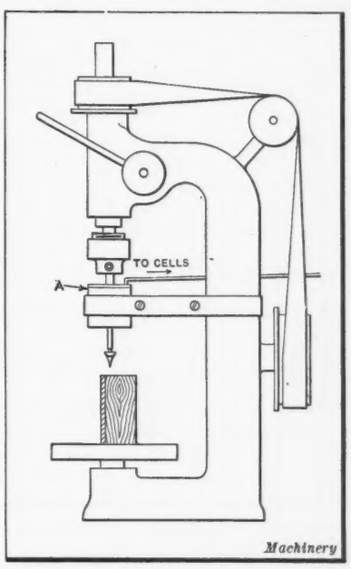
A Universal Recessing Tool

machine, as either the work or the tool can be revolved. When the tool is brought up to the work, the work presses against a ball bearing; then, as the holder is pressed against the work, the tool is forced up an inclined plane and is caused to cut.

Providence, R. I. JOHN W. HIRD

MAGNETIC SCREWDRIVER

The accompanying illustration shows a device that was used on a war order for small packing boxes with hooks and hinges screwed on. Although women did the work, the ⅛- by ¼-inch screws were too small to handle conveniently, and an electrician suggested using a magnetic screwdriver having an electromagnet energized by dry cells. The idea was applied to a small bench drilling machine. The magnet *A* was held stationary, and the screwdriver was secured to the drill spindle. A friction device was set to give the desired tightness to the screws. The work was facilitated by first piercing the wood for the screws.



Bench Drilling Machine converted into a Magnetic Screwdriver

DONALD A. HAMPSON
Middletown, N. Y.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

USE OF MERCURY COLUMN FOR TESTING VACUUM PUMPS

G. M. S.—When using a mercury column for testing a vacuum pump, what effect do the climatic or atmospheric conditions have upon the results and how should the test be made?

A.—When using a vacuum gage of the mercury type for testing a vacuum pump, the atmospheric pressure at the particular time must be taken into consideration. We shall assume that the upper end of the mercury column is connected to the vacuum cylinder and that the air is exhausted by the pump sufficiently to raise the mercury 29.5 inches. Now, in order to know just how nearly perfect this vacuum is, it is necessary to compare it with the barometer at the particular time the test is made. For instance, if the barometer stands at 30 inches at the time the pump is being tested, and the reading of the gage attached to the pump is 29.5, this indicates that the vacuum is within 1/2 inch of the barometer. Now, if this same pump were tested the next day, the reading might be 29.3 inches, but the pump would be just as good as it was the day before. The lower reading simply means that the barometer has fallen 0.2 inch, or to 29.8 inches. It is evident, therefore, that the mercury column attached to the pump cannot be used alone, but must be compared with the barometer.

TO FIND RADIUS OF CIRCLE INSCRIBED IN TRIANGLE

A. S.—In a right triangle having the dimensions shown in the accompanying illustration, a circle is inscribed; please show how to find the radius of the circle.

Answered by J. J. Clark, Scranton, Pa.

A.—The square of the hypotenuse is not quite equal to the sum of the squares of the other two sides; but, by making AC 1.3959, all three sides will be correct to four decimal places. Hence, this value will be used instead of the value indicated, 1.396. According to geometry, the bisectors of the three angles meet in a point O, which is the center of the inscribed circle. From this point O, draw the perpendiculars OD, OE, and OF; then D, E, and F are the points of tangency of the circles with the sides, and $OD = OE = OF = r$, the radius of the circle. Let S = area of triangle ABC = sum of areas of triangles AOB, BOC, and COA. Hence, $S = \frac{1}{2} \times AB \times OD + \frac{1}{2} \times BC \times OE + \frac{1}{2} \times CA \times OF = \frac{1}{2} \times AB \times r + \frac{1}{2} \times BC \times r + \frac{1}{2} \times CA \times r = r \times \frac{1}{2}(AB + BC + CA) = rs$, when $s = \frac{1}{2}(AB + BC + CA)$ = one-half the perimeter of the triangle. Since $S = rs$, $r = \frac{S}{s}$. In the present case, $S = \frac{1}{2} \times BC \times CA$; therefore, $r = \frac{\frac{1}{2} \times BC \times CA}{\frac{1}{2}(AB + BC + CA)} = \frac{BC \times CA}{AB + BC + CA} = \frac{1.8248 \times 1.3959}{2.2975 + 1.8248 + 1.3959} = 0.46161$. Evidently, the formula $S = rs$ applies to any plane triangle. Letting a, b, and c denote the sides opposite the angles A, B, and C, respectively, the area of a triangle is $S = \sqrt{s(s-a)(s-b)(s-c)}$; whence, $r = \frac{\sqrt{s(s-a)(s-b)(s-c)}}{s} = \sqrt{\frac{(s-a)(s-b)(s-c)}{s}}$.

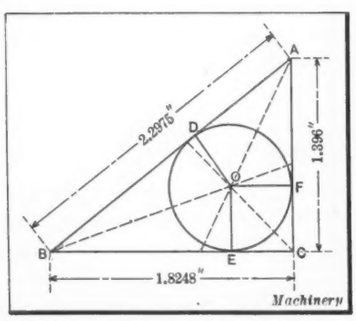


Diagram for finding Radius of Circle inscribed in a Triangle

PROBLEM IN TRIGONOMETRY

C. E. M.—Referring to the accompanying illustration, please show how to find the angle ϕ. I should like to have the method explained in detail.

Answered by J. J. Clark, Scranton, Pa.

A.—O_1C is perpendicular to OC. Draw O_1D perpendicular to O_1C; it will be parallel to OC. Through C, draw CE parallel to the tangent BD. Draw OA and O_1F perpendicular to BD; then A and F are the points of tangency of BD with the two circles. The angle $AOB = O_1ID = FO_1D = \phi$. Let $x = AB$, R = radius OA, r = radius O_1F, $a = OC$, and $b = O_1C$. $OB = \sqrt{R^2 + x^2}$; whence, $BC = DE = a - \sqrt{R^2 + x^2}$, and $FH = (a - \sqrt{R^2 + x^2}) \cos \phi$.

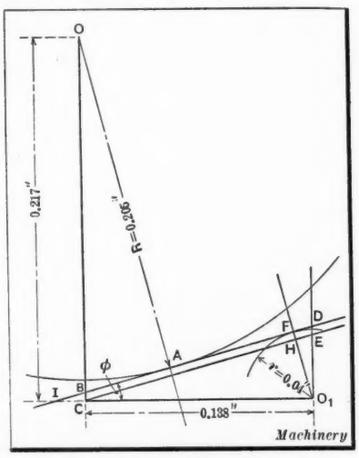


Diagram illustrating Problem in Trigonometry

$O_1H = r - FH$, $\sin O_1CH = \frac{O_1H}{O_1C} = \frac{r - (a - \sqrt{R^2 + x^2}) \cos \phi}{b} = \sin \phi$. Clearing of fractions and transposing terms, $r - b \sin \phi = (a - \sqrt{R^2 + x^2}) \cos \phi$. But $\sin \phi = \frac{\tan \phi}{\sqrt{1 + \tan^2 \phi}}$, and $\cos \phi = \frac{1}{\sqrt{1 + \tan^2 \phi}}$. Substituting these values of $\sin \phi$ and $\cos \phi$ in the last equation, there is obtained, after reduction, $r\sqrt{1 + \tan^2 \phi} - b \tan \phi = a - \sqrt{R^2 + x^2}$. Now, $\tan \phi = \frac{AB}{OA} = \frac{x}{R}$; hence, substituting this value for $\tan \phi$ in the last equation. $r\sqrt{1 + \frac{x^2}{R^2}} - b\frac{x}{R} = \frac{r}{R}\sqrt{R^2 + x^2} - \frac{bx}{R} = a - \sqrt{R^2 + x^2}$, or $\left(1 + \frac{r}{R}\right)\sqrt{R^2 + x^2} = a + \frac{bx}{R}$, and $\frac{R + r}{R}\sqrt{R^2 + x^2} = \frac{Ra + bx}{R}$. From this last equation,

$$\sqrt{R^2 + x^2} = \frac{Ra + bx}{R + r}.$$

It will be seen that the last expression contains all the given values and the unknown quantity x; by squaring and reducing, x may be obtained as the root of an affected quadratic equation, but it will entail less work to substitute the given values in the equation as it stands. Doing so, $\sqrt{205^2 + x^2} = \frac{205 \times 217 + 138x}{205 + 40}$, or $\sqrt{42025 + x^2} = 181.5714 + 0.5632653x$. Squaring, transposing, and combining terms, $0.682732x^2 - 204.546x + 9056.84 = 0$. Solving this equation by the regular rule for affected quadratics, $x = 54.0168$. Therefore, $\tan \phi = \frac{54.0168}{205} = 0.263497$, and $\phi = 14$ degrees 45 minutes 42 seconds. Note that before substituting the given values, they were all multiplied by 1000, to avoid decimals; this, of course, was not necessary, but it tends to reduce the chances of making errors.

FINDING ANGLE OF SPECIAL SCREW THREAD

A. B.—The illustration shows a section of a screw thread; please show me how to find the angles x and y.

Answered by J. J. Clark, Scranton, Pa.

A.—The dimensions when expressed as common fractions are 3/16 inch, 5/16 inch, and 1/4 inch, and the radius is 1/20

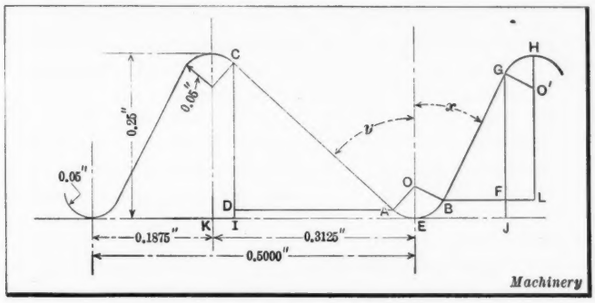


Diagram for finding Angle of Special Screw Thread

inch. As these are rather awkward numbers to handle, it will be more convenient to multiply them by 160, thus obtaining 30, 50, 40, and 8, respectively. Angle $BOE = GO'H = GBF = \alpha = 90$ degrees $- x$; $GF = 40 - 2 \times FJ = 40 - 2 \times 8\ (1 - \cos \alpha)$; $BF = 30 - 2 \times FL = 30 - 2 \times 8 \sin \alpha$; therefore, $\dfrac{40 - 16(1 - \cos \alpha)}{30 - 16 \sin \alpha} = \tan \alpha$. Clearing of fractions,

$$24 + 16 \cos \alpha = 30 \tan \alpha - 16 \sin \alpha \tan \alpha = 30 \frac{\sin \alpha}{\cos \alpha} - 16 \frac{\sin^2 \alpha}{\cos \alpha}.$$

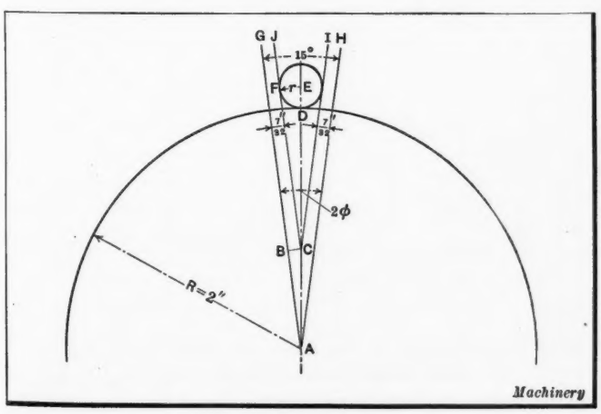
Again clearing of fractions and substituting $\sqrt{1 - \sin^2 \alpha}$ for $\cos \alpha$, $24 \sqrt{1 - \sin^2 \alpha} = 30 \sin \alpha - 16 (\sin^2 \alpha + \cos^2 \alpha) = 30 \sin \alpha - 16$, since $\sin^2 \alpha + \cos^2 \alpha = 1$. Squaring both sides of this equation, transposing, and combining terms, $1476 \sin^2 \alpha - 960 \sin \alpha - 320 = 0$. Solving this last equation by the ordinary rule for quadratics, $\sin \alpha = 0.89315$; whence, $\alpha = 63$ degrees 16 minutes 18 seconds, and $x = 90$ degrees — 63 degrees 16 minutes 18 seconds = 26 degrees 43 minutes 42 seconds. Letting β = angle CAD, find in exactly the same manner $3076 \sin^2 \beta - 1600 \sin \beta - 320 = 0$; whence, $\sin \beta = 0.67441$; $\beta = 42$ degrees 24 minutes 30 seconds; and $y = 90$ degrees — 42 degrees 24 minutes 30 seconds = 47 degrees 35 minutes 30 seconds.

FINDING RADIUS OF CIRCLE

L. A. Z.—Will you please show me how to find the radius r from the dimensions given in the accompanying illustration? I should like a formula for all such cases.

Answered by J. J. Clark, Scranton, Pa.

A.—Draw CB, in the accompanying illustration, perpendicular to AB and EF perpendicular to CF. Let R = radius AD, r = radius EF, $a = BC = 0.21875$ inch, and 2ϕ = angle $GAH = JCI$; then, $\phi = BAC = FCE = \dfrac{15 \text{ deg.}}{2} = 7$ degrees 30 minutes. $CA = \dfrac{a}{\sin \phi}$; $CD = R - \dfrac{a}{\sin \phi} = \dfrac{R \sin \phi - a}{\sin \phi}$.



Finding Radius of Circle

In the right triangle EFC, $\dfrac{r}{EC} = \dfrac{r}{r + \dfrac{R \sin \phi - a}{\sin \phi}} =$

$\sin \phi = \dfrac{r \sin \phi}{r \sin \phi + R \sin \phi - a}$. Dividing by $\sin \phi$ and clearing of fractions, $r = r \sin \phi + R \sin \phi - a$; transposing, $r(1 - \sin \phi) = R \sin \phi - a$; whence $r = \dfrac{R \sin \phi - a}{1 - \sin \phi}$, which is the formula sought. Substituting in this formula, the values given,

$$r = \frac{2 \sin 7 \text{ deg. } 30 \text{ min.} - 0.21875}{1 - \sin 7 \text{ deg. } 30 \text{ min.}}$$

$$= \frac{2 \times 0.130526 - 0.21875}{1 - 0.130526} = 0.04865 \text{ inch}$$

KYANIZING

B. H. M.—The writer has noted that in lists of building material the term "kyanized" is used in reference to wood plank. What is the principal use of kyanized plank, and how is the kyanizing process accomplished?

A.—Kyanizing, named after the inventor of the process, J. H. Kyan, is a treatment applied to wood to render it proof against decay by saturating it with a solution of corrosive sublimate (mecuric chloride, $HgCl_2$). The saturating is done either in open tanks or under pressure in closed tanks. Wood which has been kyanized is used to a great extent by textile plants in structures that are subjected to acid fumes and conditions that produce rapid decay. In cases where the commercially treated wood cannot be obtained, the kyanizing has been satisfactorily accomplished in open wood tanks by using a solution composed of twelve gallons of wood or denatured alcohol and one gallon of corrosive sublimate (50 per cent solution). It will then be necessary for the wood to soak only about two minutes; but if it can be allowed to soak for half a day, the amount of alcohol used may be reduced to three gallons, and if the wood is allowed to soak one week, no alcohol will be required.

* * *

A NATIONAL TRADEMARK

Opposition is expressed by American trade representatives in London to the movement for a distinctive national trademark to be affixed to goods of American origin. They fear that legislation along these lines necessarily carries dangerous possibilities and demands great caution and elaborate safeguards to protect American export trade interests in European markets. Their opinion is that any common national mark is dangerous to export trade unless it is absolutely restricted to a standardized quality of goods only. Such restriction is believed to be impossible of efficient application. Further, goods selling to the general public in the British and other commercially developed European markets will in no way be benefited by a displayed mark of foreign origin. On the other hand, the National Association of Manufacturers, at its recent convention in New York, endorsed the idea, especially as the national association of French manufacturers has already adopted a French national trademark, which is now being used by eighty different associations, and the manufacturers in Great Britain are supporting a movement for the establishment of an empire mark of origin, such as "British Made." The Department of Commerce also is urging the adoption of a national trademark, because of the wholesale pirating of American trademarks in Latin-American countries. Recently, one firm applied for the registration of the trademark of six of the best-known American automobiles, while another has tried to register "Ford American Products," which would give him absolute control of the use of the word "Ford" on all goods that are sold in the country where this trade name is registered.

THE SAFETY ENGINEER[1]

BY L. A. DE BLOIS[2]

Analysis of industrial accidents shows that from 15 to 25 per cent are unavoidable, and they may be passed by with the brief statement that even this number is gradually decreasing as the general knowledge of accident prevention broadens. Of the remainder, or avoidable accidents, between 10 and 20 per cent are caused by unsafe mechanical or structural conditions and are therefore possible of correction. This leaves from 80 to 90 per cent attributable to human defects, that is, to the shortcomings of the individual—ignorance, carelessness, irresponsibility, indifference, disobedience, recklessness, and inexperience of the injured or his fellow-employe—and to defects of the system, such as lack of proper supervision, discipline, etc., in the organization.

Obviously, the safety engineer may not confine his attentions solely to the elimination of those accidents for which his employer or company could be judged responsible under the common law of master and servant; he seeks to eliminate all accidents regardless of responsibility. Each accident is an interruption to output, a needless expense, a cause of suffering, and a drain on the resources of the community and of the country at large. In 1916, there were approximately 22,000 persons killed in industrial accidents in this country alone and 500,000 injured to the extent of losing over four weeks from work. Such wastage of man-power and production is enormous and constitutes a great economic loss.

A remarkable thing about the preceding analysis of industrial accidents is that it seems to apply equally well to any industry. The Dupont Co., for instance, which is engaged in the manufacture of the most dangerous materials used in both industry and war—explosives, ammunition, and strong acids—discovers about the same assignment of responsibility for accidents as does the cement industry. Mining, railroads, and other industries have the same experience. Moreover, the non-fatal and fatal accident rates on the Dupont Co.'s plants do not themselves differ greatly from the rates of other and so-called "non-hazardous" industries. Both premises lead us directly to the logical, though somewhat surprising, conclusion that neither the nature of the industry nor the character of the materials produced or handled has as much effect on the cause, frequency, and severity of accidents as the safe design and equipment of plants, the provision of a proper organization and constant supervision, and the education of the working force into habits of caution and careful practices.

Safety in Equipment

We are all acquainted with new plants where aisles are dangerously narrow, where there is insufficient headroom, where machinery is inaccessible for repairs and valves are difficult to reach for manipluation or repacking. The safety engineer who sees these conditions and recognizes that accidents will inevitably occur may be met with the objection that they have not yet caused accidents and that expensive alterations are not justified and would hold up operations. These matters could have been corrected at less expense in the original design, and probably would have been if any one with experience had considered them from this angle.

In the field of general mechanical safeguarding there has been marked progress in recent years and some excellent standards have been formulated, among them those of the American Society of Mechanical Engineers; but the more difficult problems encountered are those arising from local application and arrangement of machinery, often peculiar to the industry in question, and others due to conditions abnormal to regular operation. As a fundamental we may as well admit that no machinery can be made fool-proof in its regular operation, and we must furthermore admit that conditions occur during adjustment, oiling, cleaning, repairs, replacement, etc., under which standard safeguards may be useless or may even introduce hazard. Evidently the solution of the problem of how to make the equipment as safe as possible under all conditions cannot be reached through mere general acquaintance with machinery of the class in question, nor by a casual inspection of the plant in normal operation. The problem will yield only to analysis after a painstaking study of all phases of operation and of conditions such as poor lighting, inaccessibility, and congestion which are contributory to accident.

Safety through Supervising and Educating Workers

The majority of accidents are due to the shortcomings of human nature, to personal tendencies and traits in the individuals liable to injury, and to deficiencies in the organization that employs, instructs, holds in restraint and disciplines them. Here the safety engineer must employ his knowledge of psychology and the principles of industrial organization. His greatest aids will be diplomacy, perseverance, tact, and patience with the slow response to his insistent efforts to change the mental viewpoint; but there is in this branch of the work a principle so important that its neglect will bring failure in place of success; it is a clear recognition of the fact that the safety engineer can no more effect general accident reduction by his direct efforts alone than the doctor can make a healthy community by curing the sick.

The safety inspector or safety engineer should be able to tell whether a certain practice is dangerous when he sees it, but he cannot watch all the practices of a thousand working men, or even a hundred. The one class of men who can perform this function most efficiently are the foremen, but some one must instruct the foremen as to what is dangerous. This is the function of the safety engineer or inspector. However, an executive authority immediately above the foreman must first convince him, and continue to convince him, that he is required to supervise properly for safety. The plant manager must place himself clearly on record to the effect that safety is as important in the day's work as production or quality, for it is from him that the organization takes its tone. From the directing officials of the company must come moral and financial support. Thus the whole organization is involved. All must work for safety, with the safety engineer in the position of technical adviser.

Relation of Safety Engineering to Other Branches of Engineering

Some instruction in the fundamentals of safety engineering should be given a place in the training of every young engineer. He should be taught to think in terms of safety as he now thinks in terms of efficiency. Conservation of life should surely not be rated below the conservation of energy. Yet few of our technical schools and universities offer instruction in this subject and the graduates go out to their profession with only vague surmises on "what all this talk on safety is about." We have safety inspectors by the hundred, but scarce, indeed, are safety engineers—technically trained and experienced men who are capable of studying an industry or process from all its angles and of making constructive recommendations for changes in design and operation which strike to the root of the unnecessary accident evil.

The National Safety Council is the representative organization of the country dealing with safety. Since its foundation in 1912, its activities have extended until its membership now represents the employers of over 6,000,000 men. The safety of this vast army of workers should be in the hands of trained men, but there are few to fill the vacancies that exist today and the new positions that will be created tomorrow. If there was ever need for a national campaign to reduce death and disablement from industrial accidents, that need is today. They tell us that at least three workers are necessary at home to supply one man at the front. By workers is meant producers—not hospital patients—and the war will bring us enough reconstruction problems in the employment of war cripples and returned soldiers without the problem of employing the many men crippled in our industries. Let us realize, then, that "safety" is not a passing fad, but real work for real engineers, and that the sooner we accept this viewpoint the less cause shall we have later to regret the days of complacent inaction.

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[1] Abstract of a paper presented at the spring meeting of the American Society of Mechanical Engineers at Worcester, Mass., June 5.

[2] Safety Engineer, E. I. du Pont de Nemours & Co., Wilmington, Del.

THE DUTY OF EMPLOYERS WITH RELATION TO CRIPPLED SOLDIERS

In a paper prepared by Douglas C. McMurtrie, director of the Red Cross Institute for Crippled and Disabled Men, 311 Fourth Ave., New York City, attention is called to the fact that the only sound method of dealing with the crippled soldier is to train him for a trade in which his physical disability does not incapacitate him. The American Red Cross is inaugurating a campaign to promote general intelligence regarding the true needs of men incapacitated while fighting for their country. The disability of some crippled soldiers is no bar to their returning to their former trade, but the injuries of many disqualify them from pursuing again their past occupation. The schools of training prepare these men for some work in which their physical handicap will not materially interfere with their production.

In the readjustment of the crippled soldier to civilian life, his proper employment is a matter of the greatest moment, and in this connection the employer has a very definite responsibility; but the employer's duty is not entirely obvious. It is, on the contrary, almost diametrically opposite to what one might superficially expect it to be. The duty is not to "take care of," from patriotic motives, a given number of disabled men, finding for them any odd jobs which are available, and putting the ex-soldiers to work without much regard to whether they can earn the wages paid or not. This method is absolutely erroneous. The positive aspect of the employer's duty is to find for the disabled man a constructive job that he can hold on the basis of competency alone. In such a job he can be self-respecting and happy, and look forward to a future. This is the definite patriotic duty. It is not so easy of execution as telling a superintendent to take care of four men, but there is infinitely more satisfaction to the employer in the results, and infinitely greater advange to the employe; and it is entirely practical, even in dealing with seriously disabled men.

With thoughtful effort, many men can be employed directly on the basis of their past experience. With the disabled soldiers who profit by the training facilities the Government will provide, the task should be even easier. This, then, constitutes the charge of patriotic duty upon the employer: To study the jobs under his jurisdiction to determine which ones might be satisfactorily held by cripples; to give the cripples preference for these jobs; to consider thoughtfully the applications of disabled men for employment, bearing in mind the importance of utilizing to as great an extent as possible labor that would otherwise be unproductive; to do the returned soldier the honor of offering him real employment, rather than proffering him the ignominy of a charity job.

* * *

REPAIRING A LARGE BORING MILL TABLE

The cutting of cast iron with an oxy-acetylene or other high-temperature cutting torch is generally considered impossible because the melting temperature of the oxide which forms on the cast iron is higher than that of the metal itself.

Fig. 1. Cast-iron Table of Large Vertical Boring Mill

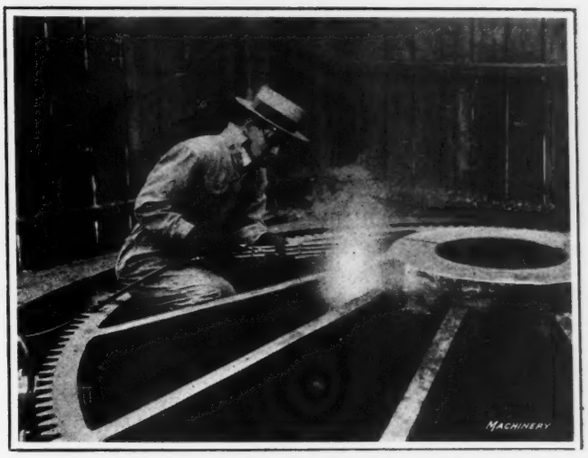

Fig. 2. Cutting out Sections of Ribs with Oxy-acetylene Torch, to repair Cracked Hub

Wrought iron or steel has a higher melting temperature than the oxide of iron which forms when the oxygen jet of the cutting torch is applied; consequently the oxide melts and either flows or is blown away from the surface against which the flame is directed. As the result of this constant removal of the oxide in the case of wrought iron and steel, new surfaces are continually exposed to the action of the oxygen jet, so that the metal is literally burned as the cutting proceeds. The difficulty in cutting cast iron is due to the fact that the metal melts sooner than the oxide and the latter interferes with a burning or oxidizing action.

Notwithstanding this theory, an oxy-acetylene torch was used very effectively at the Graves Machinery Exchange, 305 Johnson Ave., Jersey City, N. J., for cutting away sections of the ribs of a large cast-iron boring mill table in connection with its repair. This table, which is shown in the accompanying illustrations, Figs. 1 and 2, was badly cracked through the hub, and as it is part of a fourteen-foot boring mill and weighs about twelve tons, it would have been very expensive to replace. In order to strengthen the hub, it was decided to shrink around one end a 4- by 4-inch steel ring, which involved cutting away sections of the 2¼-inch ribs in order to form a place for the steel ring.

Fig. 1 shows a view of the boring mill table, and this illustrates how the ribs have been cut away next to the hub. Fig. 2 shows how an oxy-acetylene torch was used for this purpose. This torch has six small holes in the tip for the preheating jets which surround a larger central hole for the oxygen. Attempts were made to cut the casting with a tip having only four outer holes, but this form of tip could not be used. The torch is adjusted to give a rather long preheating flame. The pressure of the acetylene is about 30 pounds per square inch, and of the oxygen, 90 pounds per square inch. This method of removing the rib sections saved considerable time, as a 4- by 4-inch piece was cut out of each rib in ten or twelve minutes by means of the torch. The edges of the cut-out sections were left soft and could easily be trimmed by chipping. While the composition of this casting is not known, it probably contains considerable scrap. It is claimed, however, that other cast iron of the gray iron variety has been cut successfully.

F. D. J.

* * *

WAR COMMITTEE, TECHNICAL SOCIETIES OF CHICAGO

The technical societies centered in Chicago have formed a joint war committee, the object of which is to cooperate effectively and vigorously in all war activities. The committee is known as the War Committee, Technical Societies of Chicago. The purpose of this organization is to enable the technical societies to call into play the efforts of their members as occasion may arise, and to coordinate their various activities in the most effective manner to help win the war. The secretary is Edgar S. Nethercut, whose offices are at 1735 Monadnock Block, Chicago, Ill.

THE LABOR PROBLEM OF THE SMALL MANUFACTURING PLANT

BY A MANUFACTURER

The small and medium-sized manufacturing plant is facing a serious difficulty on account of the present labor conditions, especially in localities where there is a great deal of manufacture of munitions and other war materials. The latter industries are able, on account of the prices that they receive from the Government and the methods under which the contracts have been let, to pay much higher wages than a manufacturer engaged in a regular line of machinery. Many of the early war contracts were let on a cost-plus-percentage basis which enabled the contracting manufacturers to pay any price for labor and made it possible for them to draw their labor supply from the plants of manufacturers engaged in regular commercial lines. In the face of these conditions, many manufacturers have been forced to curtail their production, not because their industry is non-essential, but because their product is of such a nature that they are not in a position to increase prices appreciably. There are many small and medium-sized plants in and adjacent to cities where large munition factories are located that work now at only about 50 per cent of their capacity; and if there is not soon an improvement in the conditions, some of these manufacturers will be forced to close their plants entirely.

The Small Manufacturing Industry is Vital to the Country

Many of these smaller manufacturing industries make tools and supplies that are just as essential to the effective prosecution of the war as are the actual war materials. Hence, the shutting down of these plants would seriously hamper the nation in its present undertaking. Furthermore, it is the small and medium-sized plants of today that will be the large manufacturing plants of tomorrow. It is often the manufacturer of limited resources who is most active in development work along mechanical lines, and to hamper him is to hamper the progress and growth of the whole industry.

What we need in order to keep the nation fit for an effective prosecution of the war is a policy that keeps all useful industries at their maximum vitality and vigor. At the present time, the thing most important in order to accomplish this is for the Government to inaugurate some policy whereby the small manufacturer may be assured of a reasonable labor supply. This might be done by increasing the authority of the labor bureaus already established in our larger industrial centers by the Department of Labor, so that these bureaus would have the power to pass upon the justification of any man changing from employment in one plant to another. No men should be hired unless they pass through this labor bureau. Their reasons for changing should be investigated, and in case the change was shown to be detrimental to the best interests of the nation at large, in that it made it impossible for the smaller industries to conduct their business properly, it should not be authorized. A system similar to this is in force in England and appears to work very satisfactorily. In England, wages also are regulated by the Government, the manufacturers, and the labor organizations in cooperation with each other, but this would probably not be necessary here if only the Government would aid the industries by regulating the all too frequent changes of employment that take place.

Present Labor Bureaus are Useless as Regulators of Labor Supply

The employment bureaus so far established by the Government do not sufficiently protect the manufacturers who operate small and medium-sized plants. As an example of how ineffective the present arrangement is, it may be mentioned that when a manufacturer in a city with large war industries recently laid his troubles before the officials of the bureau, he was asked what rates of wages he would pay mechanics such as he required. He supplied these figures to the Labor Bureau. Upon comparison with the rates of pay in the large munition factories, his rates were low, and all the comfort he received from the Labor Bureau was to be told that of course he could not get any labor as long as he paid so much less than the prevailing rates at the other large plants.

Now, the manufacturer did not need to go to a labor bureau to become aware of this. He knew well enough that the source of his troubles was that the munition plants outbid him. He also knew that he could not possibly pay the rate of wages that the manufacturers of war materials could afford, because his product had to be sold largely in an open market that would not allow of raising prices to such an extent. Furthermore, he knew that if he could bid as high as the munition manufacturers he could get all the labor he wanted. What he expected from the Labor Bureau and what manufacturers in general should have a right to expect from the Department of Labor is the establishment of an authority that could prevent unfair labor market competition. A manufacturer who at this time tries to obtain skilled labor from another manufacturer by offering exorbitant wages, rather than train men himself, should not be permitted to do so, and the Labor Bureau should be the regulating influence.

Small Factories Train Men for the Larger Plants

The small factory has been made a training school for the large munition plants. In many instances, the smaller plant takes in green men constantly, trains them for a few months, and when they are capable of producing they are absorbed by the larger plants, which can afford to pay them higher wages and which thereby also benefit by the training for which the smaller plant has paid. A labor bureau having sufficient authority could overcome this difficulty of the small manufacturer and could make the larger plants train their own labor to meet their own requirements.

For the national welfare, it is certainly necessary that something be done to regulate the labor supply, so that the manufacturer who is not in a position to realize more than a normal return on his investment and who cannot reimburse himself for the payment of exorbitant wages by charging proportionately high prices for his product may receive some protection. In order that we may be able to continue the war without unnecessarily sacrificing or retarding industrial development for years to come, all industries that perform a useful service, and particularly those directly or indirectly aiding in the prosecution of the war, should be given all the assistance possible, or at least they should not be discriminated against. If this is done, healthy activities on the part of small and medium-sized manufacturers may be encouraged, industrial development will be insured, and labor will gain by the stability of employment.

* * *

WAGES FIXED FOR MACHINISTS AND TOOLMAKERS

The Labor Adjustment Board of the Army Ordnance fixed the wage rates of machinists in the Bridgeport, Conn., district, June 7. The board decided upon the following rates of pay per hour: Toolmakers, 78 cents; special tool-room helpers, 64 cents; all-around machinists, 68 cents; medium and rough-work machinists, 64 cents; lathe hands, 59 cents; planer hands, 64 cents. These rates per hour are on a basis of an eight-hour day, with pay for all over-time at the rate of time-and-one-half. Work on Sundays and holidays shall be considered as overtime. Those who receive rates of pay in excess of the rates mentioned shall not be reduced in their present employment because of the decision rendered by the board, and all employers who have been paying more than time-and-one-half on Sundays and holidays are to continue to pay the higher rate. Any disputes in regard to classification of men in accordance with the wage scale are to be referred to a representative designated by the War Department, and his decision in each case shall be final and binding.

* * *

Although Japan began the manufacture of machine tools ten or fifteen years ago, the most progress has been made in the past four years. Jigs and fixtures and powerful plain milling machines, however, are used comparatively little; probably because there is little specialization. Turret lathes are much appreciated, but the cheapness of labor has prevented the rapid introduction of automatic machines.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

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COMMUNITY THREAD-GAGE GRINDING MACHINE

On this gage-grinding machine, a wheel-truing device is provided with which to dress wheels for grinding U. S. standard, Whitworth, or Löwenherz threads. Interchangeable spindles are furnished, carrying grinding wheels trued to these three forms, and changes of spindle may be rapidly made. A set of master screws is furnished with the machine, which correspond in lead to the different thread gages that have to be ground. A graduated swivel provides for adjusting the grinding wheel for the helix angle of the thread.

FOR use in grinding thread gages, the Community Machine & Tool Works, Inc., 154-156 Grand St., New York City, is now building a machine which forms the subject of the following description. This thread-gage grinding machine was originally designed and built for use in grinding thread gages made by this company, but the results obtained have been so successful that subsequently a decision was reached to build the machine for the general market. Before starting upon a detailed description of features of the design, it will be of interest to state briefly the way in which the machine operates for the benefit of those who have not had experience in thread-gage grinding.

The work is mounted between centers, and grinding is done by a wheel which is accurately trued up to exactly the required form for the thread that is being ground. While the grinding operation is being performed, it is necessary to provide for both rotating the work and traversing it past the grinding wheel. This result is accomplished by means of the crank handle which will be seen at the extreme right-hand end of the machine. This crank is attached to the spindle, which carries an interchangeable master screw of the same lead as the thread gage that is being ground; this screw runs in a nut, so that as the spindle is rotated the work receives a corresponding rotary motion through connection made between the work and spindle by a driving dog, and the work is traversed past the grinding wheel at the proper rate, owing to the screw on the spindle to which attention has just been called. In order to provide for this traverse movement, the dead center at the left-hand end of the work is held in contact with the work by means of a compression spring. Consequently, traverse motion of the work is accomplished by pushing the center back against this spring tension. Attention is called to the fact that as soon as the traverse movement has been completed in one direction, the machine operator simply reverses the direction in which he has been rotating the crank, thus feeding the work back past the wheel with the work rotating in the opposite direction. In this way, no time is lost in the performance of the grinding operation.

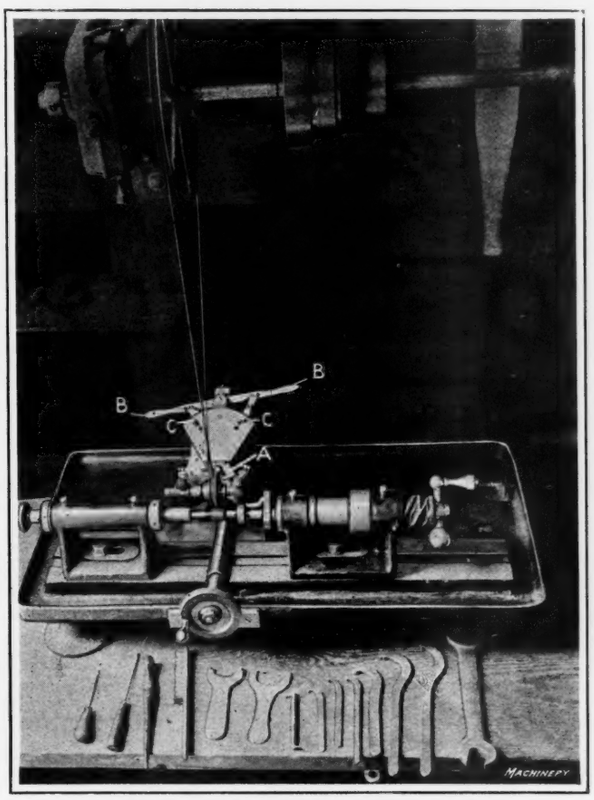


Fig. 1. Thread-gage Grinding Machine built by the Community Machine & Tool Works

It is important for the nut in which the master screw runs to be a close fit, and before starting to describe the provision made for assuring a tight fit of the nut on the Community gage-grinding machine, attention is called to Fig. 2, in which there is shown a close view of one of the interchangeable master screws and nuts. The screw thread is cut on a steel sleeve that is held in place on the spindle by lock-collars; and the nut, which is made of bronze, is tapered on the outside with a straight threaded section below the taper. An adjusting collar goes on the outside thread, and by tightening this collar, the nut is pulled into its seat in the machine frame, thus assuring a close-working fit between the screw and nut. As shown in the illustration, the machine is said to have given perfectly satisfactory results, but a point was raised concerning

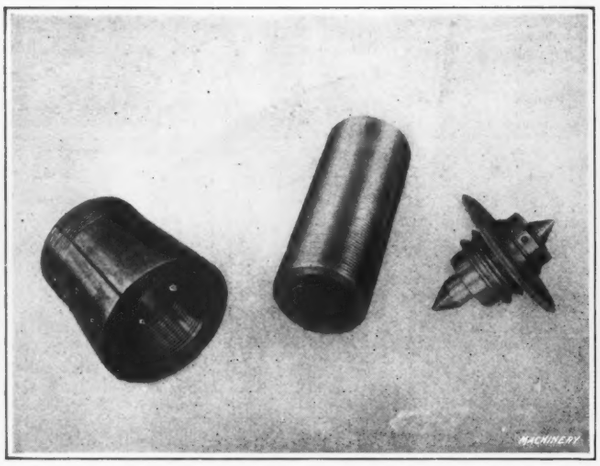


Fig. 2. Close View of Nut, Master Screw, and Grinding Spindle for Community Thread-gage Grinding Machine

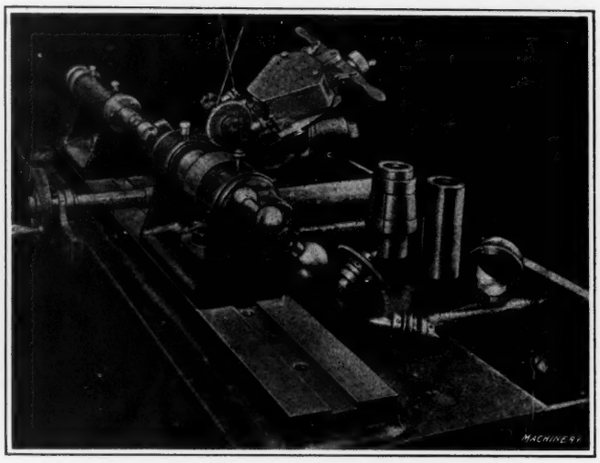


Fig. 3. End View of Community Thread-gage Grinding Machine, showing Graduated Swivel to adjust for Helix Angle

whether the spindle is subjected to unnecessary strain by having the crank handle mounted directly on it. On this account, an improved design is now being developed, where the end of the spindle is square to slide in a corresponding opening at the end of a sleeve on the opposite end of which the operating crank will be carried. In this way, the spindle will be relieved of all unnecessary strain.

This machine is used for grinding U. S. standard, Whitworth, and Löwenherz threads; and, of course, different shaped wheels must be provided for grinding each form of thread. To obviate the necessity of redressing the wheel to different shapes each time a change is made on the class of work that is being ground, interchangeable spindles are provided for use on the machine, on which the different forms of wheels are permanently mounted. One of these spindles with its grinding wheel is shown in Fig. 2, where it will be seen that at each end the spindle is provided with a 60-degree tapered center. These centers fit into corresponding sockets carried in the wheel-head, and when it is desired to change wheels, it is merely necessary to loosen a binding screw and move one of the sockets back sufficiently so that the spindle can be removed and another one substituted in its place. This change of spindles can be made with very little loss of time.

For truing the grinding wheel there is an attachment permanently secured to the machine that is furnished with means of adjustment to provide for truing wheels for grinding any of the three forms of thread to which reference has been made. Extending out of the attachment at each side of the grinding wheel, there is a bar which carries a diamond point (one of these bars is clearly shown at *A*, in Fig. 1). Truing of the grinding wheel is accomplished by imparting an oscillating movement to the diamond holders by rocking lever *B* about its central pivot. Connection is made from this lever to the diamond holders by means of pivoted links clearly shown in the illustration. When lever *B* is rocked, an oscillating movement is imparted to the diamond holders, which results in carrying first one diamond and then the other over the face of the grinding wheel, causing the wheel to be accurately trued to exactly the desired form. For truing wheels for grinding U. S. standard, Whitworth, or Löwenherz threads, adjustment is provided on the wheel-truing attachment to make the two bars *A* which carry the diamonds travel past the grinding wheel at exactly the proper angle for each form of thread, namely, 60 degrees for the U. S. standard thread, 55 degrees for the Whitworth thread, and 53 degrees 8 minutes for the Löwenherz thread. This adjustment is accomplished by pulling out pins *C*, which control the position of the diamond-bars in the attachment and entering these pins into the proper holes for the particular type of thread for which the wheel-truing attachment must be set. Patents have been applied for on certain features of the design of this machine.

DUFF HEAVY-DUTY TURRET LATHE

In the accompanying illustrations there are shown three views of a new heavy-duty 26-inch turret lathe, built by the Duff Mfg. Co., of Pittsburg, Pa. This machine was designed for the heavy work encountered in machining ammunition and for other similar service. The operative control is so designed as to be easily accessible at all times to the operator, thus reducing to a minimum the amount of actual labor required in operation. This turret lathe has a length over all of 13 feet 7 inches and a swing over the ways of 27 inches. Mounted on the top of the headstock there is a 20-horsepower motor, from which power is transmitted to a driving pulley 10½ inches in diameter (constant speed, 1000 revolutions per minute) at the rear of the headstock by means of a silent chain drive, and thence through a train of gears to the spindle. Twelve mechanical changes of speed are provided—open and reverse—giving a range of from six to one on low gear to one hundred seventy-four to one on high gear. These speed changes are controlled by levers within easy reach of the operator. Conveniently located, behind the chuck at the top of the headstock, is the starting, stopping, and reversing lever.

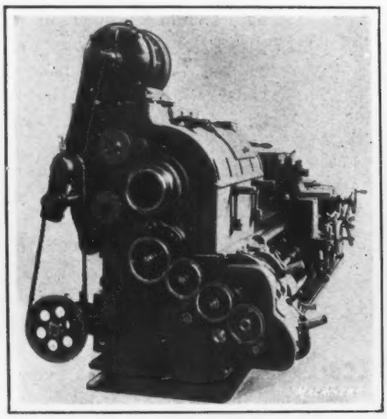


Fig. 1. Duff Heavy-duty Turret Lathe

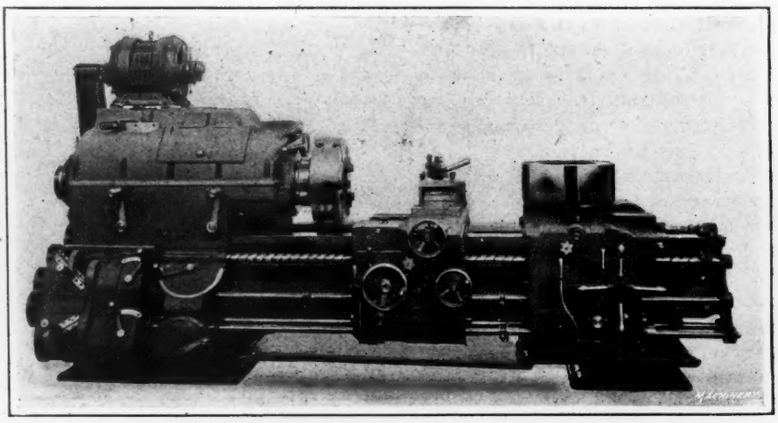


Fig. 2. Front View of Heavy-duty 26-inch Turret Lathe built by the Duff Mfg. Co.

The spindle is a hammered steel forging, heat-treated and ground. At the rear of the spindle is placed a ball thrust bearing. To insure proper lubrication along the entire length of the spindle, a well is provided in the cap, from which wicks carry the oil, covering the full length of the bearing. The hole through the spindle is 7⅛ inches in diameter, and the chuck, which is 20 inches in diameter, is of the compound, three-jaw, universal type. The turret is of the broad-faced, hollow, hexagon type, containing tool holes 3½ inches in diameter and measuring 21 inches across the flats. It rests on a base 30 inches in length, and is clamped by means of the handle shown at the base. This clamp-handle permits a powerful clamp over the entire surface of the turret base, which is sufficient to hold the turret firmly against play under the heaviest work. The turret carriage has a travel of 45 inches, and the turret is of the automatic indexing type. The geared feed changes of the turret are absolutely independent of the toolpost feeds, resulting in the advantage that a very fine feed can be used for boring or facing, and at the same time a very coarse feed can be used for the toolpost. The long lever at the left of the turret apron is the quick-return lever, which provides for moving the turret forward with the same speed that is obtained in reversing. The feed-lever is located at the right of the quick-return lever. A large pilot wheel is used on the turret apron for operating the turret backward and forward by hand, and adjustable automatic knock-out stops are provided, which operate instantly and accurately—an essential feature when handling duplicate work. Feeds can also be engaged or tripped as desired by hand operation through use of the feed-lever shown on the turret apron.

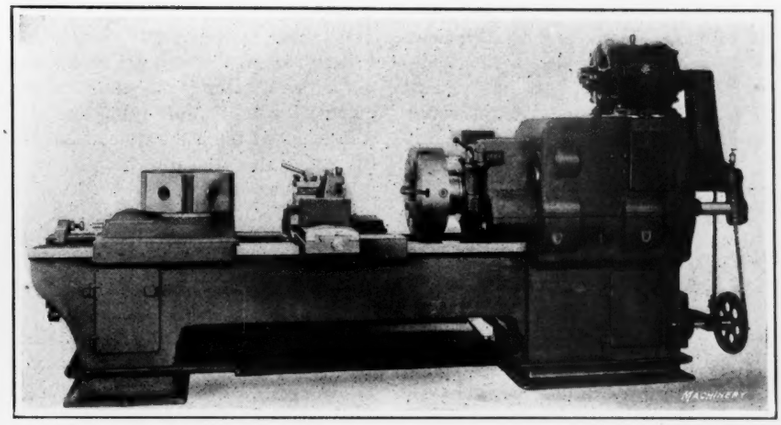


Fig. 3. Opposite Side of Duff Heavy-duty Turret Lathe shown in Fig. 1

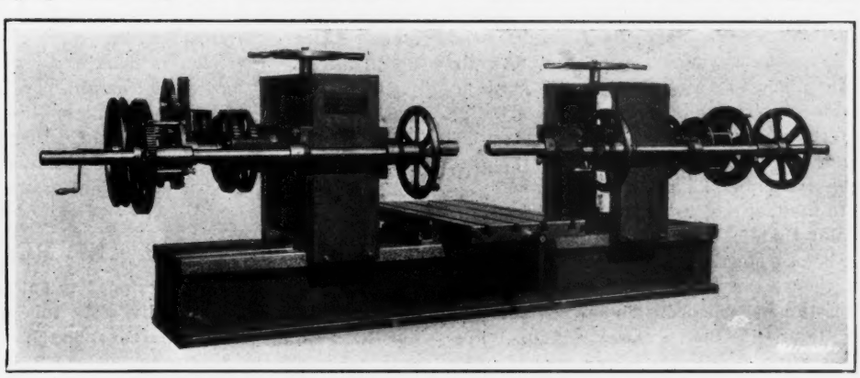
The toolpost carriage is heavily built and of special design, having front and rear tool-slides with power and hand feed in both directions. Either toolpost can be clamped and locked rigidly in any one of a number of positions, as they operate entirely independently of each other. The toolposts are of the side carriage type, and can pass completely by the chuck, permitting greatly increased capacity in relative swing over the carriage and increasing the range of chucking work that the lathe can accommodate; also, it permits the toolpost to be moved completely out of the way when using the tools in the turret, it being possible to bring the turret-head up close to the chuck. The carriage can be firmly clamped to the bed to hold it in a fixed position. The toolpost feeds are absolutely independent of the turret feeds, providing advantages already outlined. The feed changes for the toolpost carriage are so arranged that it is possible to shift instantly from any heavy roughing feed to a proper finishing feed. All feeds are reversible. Adjustable automatic trip-off stops are provided, which operate instantly and accurately. The feeds can be engaged or tripped at will by hand, through the use of a lever handle shown in the illustration at the right of the quick-return lever. Three handwheels are provided on the apron, one for adjusting each of the two toolposts, and one for feeding the carriage forward or backward.

One of the most notable features of the Duff heavy-duty 26-inch lathe is its efficient system of lubrication. This is taken care of by a single pump located at the rear of the headstock and driven by the lathe motor. By means of this pump, every single point in the machine demanding lubrication is automatically supplied with oil. Care has been taken to make this machine as fool-proof as possible. The danger of stripping gears, through changing spindle speeds while the lathe is in operation, has been eliminated by the use of a safety governor, which works automatically, unlocking and allowing the changing of spindle speeds only when the machine has been thrown out of motion. Another desirable feature of the Duff lathe is the use of a knock-out box containing a train of gears, acting on the feed-shafts, and controlled by two handles, which are used for reversing the feed-shafts. In building this machine, great care was exercised to design it so that it could be readily adapted for a single-purpose machine for ammunition work. All non-essentials for the work required can be omitted. This machine can be built as an engine lathe, and as such it is amply strong to handle shells up to and including 15 inches in size. It can be furnished with any number of speeds up to twelve, with any number of feeds up to ten, with any size of spindle hole up to 10 inches, and with any length of bed.

PEDRICK DUPLEX BORING MACHINE

Among the machines which have fulfilled special war requirements is the one illustrated herewith. It was originally designed with only one boring-bar, but was easily arranged for using two bars, one in each housing, and in this form is serving a useful purpose in ordnance shops. Several plants using this machine have adapted jigs of proper construction to suit their individual requirements, and in connection therewith are using the duplex horizontal boring machine for turning trunnions and boring the bearings in gun carriages. A bed, planed and scraped on its bearing surfaces, forms a base for two box-like housings. These are movable along the bed to suit conditions and are securely locked in position by four bolts. In each housing is a complete boring-bar or spindle having its own driving gearing, feed mechanism, and motor. Handwheels above the housings are for vertical adjustment of the bars.

The bars are held in a long bearing in the form of a quill, so machined that accurate alignment of the bar is assured. A feed-case on the end of the bar regulates the feed of the bar, there being three changes controlled by a slip pin. The feeds are reversible. In order to bring the feed control nearer the work, a shaft is run to a gear engaging another gear on the feed-case and a handwheel located at the side of each housing. One of the features of



Horizontal Duplex Boring Machine built by the Pedrick Tool & Machine Co.

this new feed is the rapid return of the bar. A crank handle shown at one end of the feed-case operates this movement. The driving gearing on the bar is compounded in such ratio that motors of small horsepower are ample. The gear guard cover is designed to form a base for the motor, and a swing-arm, on which various sizes of gears may be applied, transmits the power from the motor to the driving power pinion. In the end of the bars is a Morse taper hole for holding drills, auxiliary bars, facing heads, etc. Two sizes of the machine are made for carrying 3- or 6-inch bars. This machine is a recent product of the Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia, Pa.

GRAND RAPIDS DRILL GRINDING MACHINES

The Grand Rapids Grinding Machine Co., Grand Rapids, Mich., is now building a line of drill grinding machines which comprises four different styles, two of which are shown in the accompanying illustrations. The Style C3T machine, shown in Fig. 1, has a capacity for grinding drills from ¼ inch to 2½ inches in diameter, and it will be seen that this machine is furnished with a water attachment for wet grinding. In Fig. 2 is shown a Style B2T drill grinding machine, which has a capacity for sharpening drills from ⅛ to 1½ inch in diameter; and it will be seen that on this machine no water attachment is provided. In addition to the two styles of machines illustrated, there is a Style B3T machine, equipped with a water attachment and having a capacity for sharpening drills from ⅛ to 1½ inch in diameter; and a Style C2T machine, without a water attachment, which has a capacity for grinding drills from ¼ inch to 2½ inches in diameter. Aside from differences in capacity and the provision of a water attachment, the design of all of these machines is quite similar.

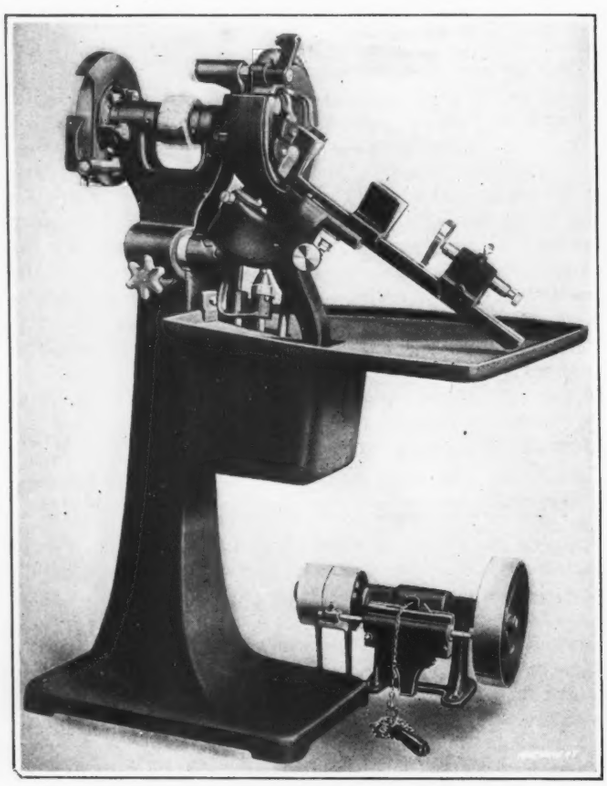


Fig. 1. Grand Rapids Style C3T Drill Grinding Machine

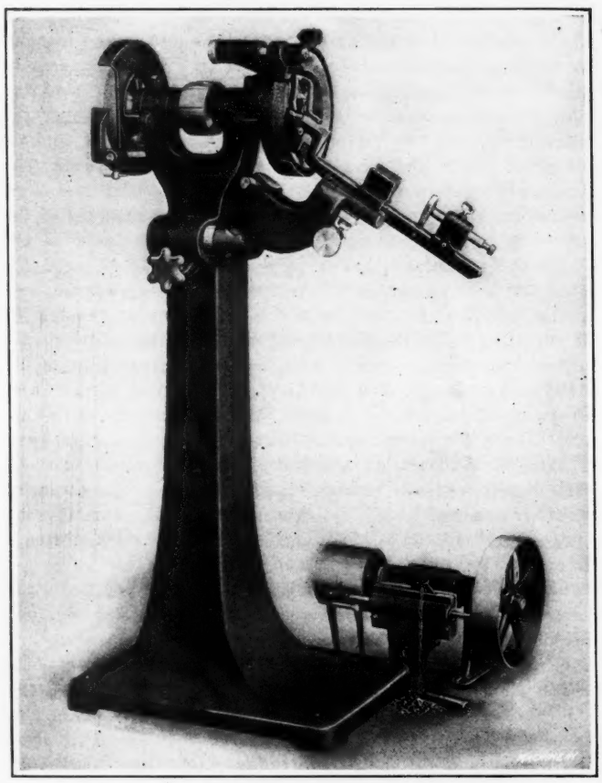


Fig. 2. Grand Rapids Style B2T Drill Grinding Machine

Attention is called to the fact that the machines work on the non-calipering principle; that is to say, it is unnecessary to make an adjustment before starting to grind different sizes of drills, other than to set the tailstock for the particular length of drill which is to be sharpened. The swivel bearings are made of ample size to provide the necessary stiffness. Provision is made on the standard holder for taking care of drills with enlarged shanks, as well as those with the standard straight or tapered shanks. The spindle is made of from 60- to 80-point carbon crucible steel, and is carried in ring-oiled bronze bearings. On these machines, a diamond truing device with a safety stop is one of the important features. It insures getting the drill-holder into close proximity with the grinding wheel and at the same time eliminates danger of bringing the lip rest against the wheel and causing it to be ground off.

The diamond truing device consists of a swinging arm in which the diamond is mounted. Adjustment may be conveniently made. In the case of double-holder machines, a truing device is furnished for both wheels, and a diamond is part of the standard equipment furnished with each device. In connection with the truing device, a stop is provided which is in the form of a track on a movable section of the wheel hood. As the diamond is advanced into the grinding wheel during the process of truing, this movable section of the wheel hood with its track is advanced an equal amount, so that it always remains at a fixed distance from the face of the grinding wheel. A circular stop on the front of the drill-holder abuts against the track and rocks on it during the process of swiveling the holder. It is so adjusted that it brings the lip rest into close proximity to the wheel, which is desirable in drill grinding. At the same time, it is impossible to get the front of the holder or the lip rest against the grinding wheel, where it would be ground off.

Drills working on tool steel require less clearance than those engaged in drilling soft gray iron, while the drills working in steel require a stronger cutting edge than those which are drilling iron. Provision is made for rapidly making an adjustment of the amount of clearance provided in grinding a drill. In making this adjustment on the Grand Rapids machines, there is no danger of getting other adjustments on the machine out of order. It is merely necessary to turn a small handwheel which rocks the drill-holder the proper amount.

HALLDEN TUBE AND ROD CUTTER

This machine has been designed to cut tubes and rods into short accurate lengths rapidly. The tube or rod is fed to the saw by a pair of feed-rolls revolving intermittently, and at each pause of the feed-rolls the saw table is raised and a piece of metal is cut off. On the smaller sizes of work, two

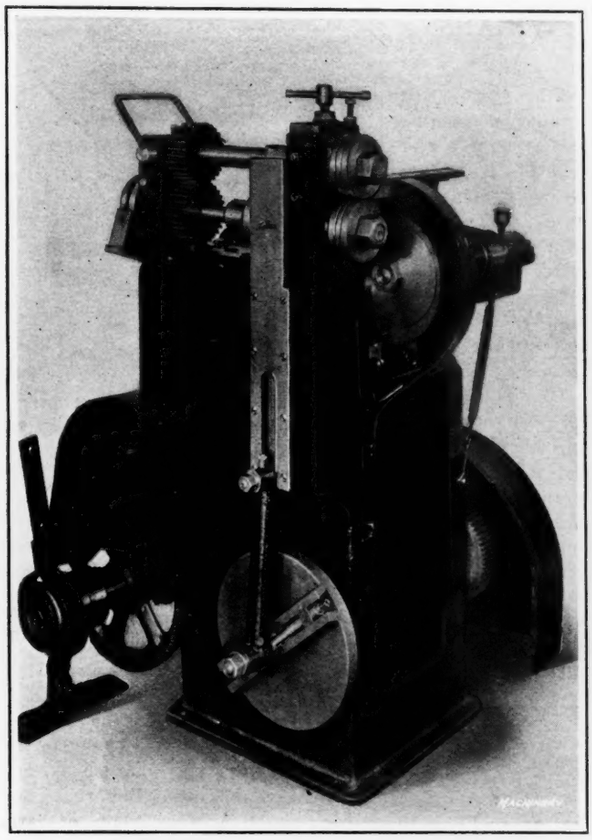


Fig. 1. Tube and Rod Cutting Machine built by the Hallden Machine Co.

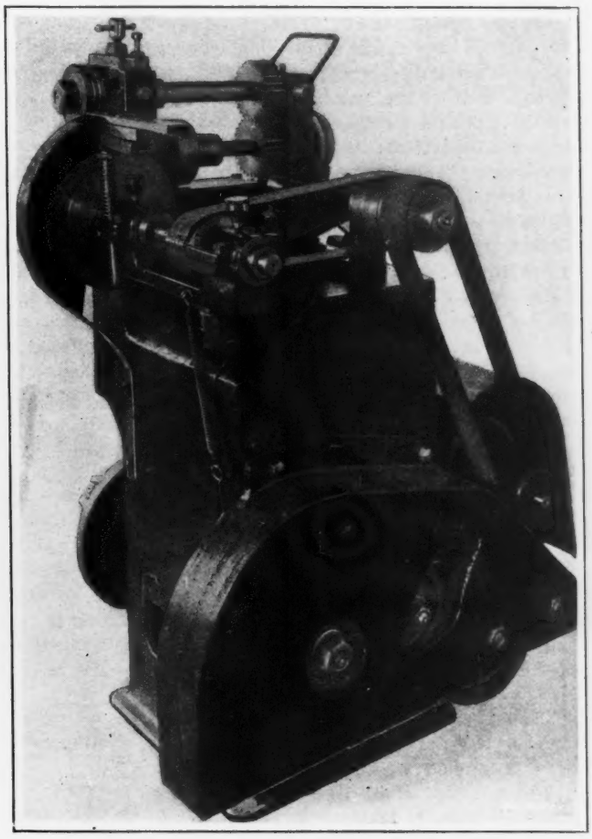


Fig. 2. Opposite Side of Hallden Tube and Rod Cutting Machine

tubes can be cut at the same time. The feeding mechanism consists of a reciprocating rack with one end connected by a lever to an eccentric and the other end meshing with a gear connected to a one-way clutch. Thus on the upward stroke of the rack the feed-rolls are revolved forward, but on the downward stroke the feed-rolls stand still, and the saw table is raised upward by a cam connected directly to the shaft driving the feeding mechanism.

During the time the saw passes through the metal the tube or rod is held firmly by the feed-rolls and stock casing, and the piece being cut off is held by a clamping device, which releases as soon as the saw has passed through the metal. The eccentric can be adjusted quickly to give any length of stroke to the rack, thus enabling the machine to cut any desired length. When cutting brass or copper, a regular metal saw is used, but on steel a metal disk rotating at high velocity gives the best results. The machine is a recent product of the Hallden Machine Co., 27 Benedict St., Waterbury, Conn.

SHEPARD LATHES

The line of screw-cutting engine lathes manufactured by the Shepard Lathe Co., Canal and Jackson Sts., Cincinnati, Ohio, has been increased by the addition of several new types of machines. Among these are the 12-inch, all-geared head, semi-quick-change screw-cutting engine lathe, equipped for various styles of drives, such as individual motor drive mounted on either the headstock or on the lathe leg, and countershaft and single-pulley drive. These lathes include the well-known Shepard features, such as the semi-quick-change attachment

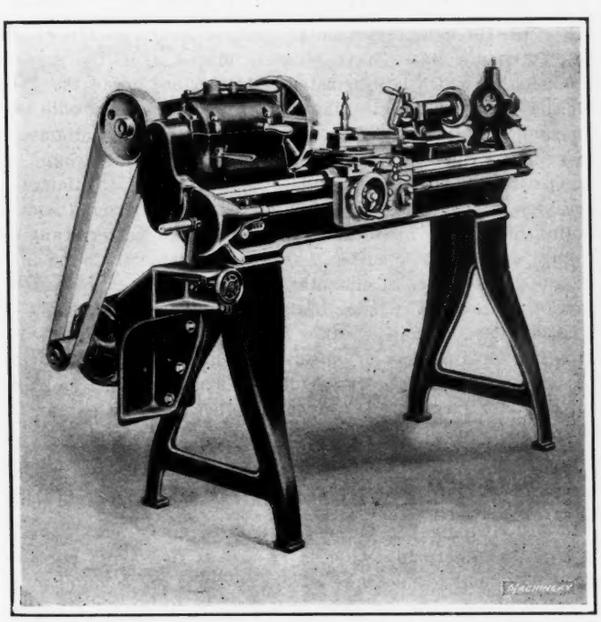


Fig. 1. Shepard 12-inch Engine Lathe with All-geared Head and Motor mounted on Leg

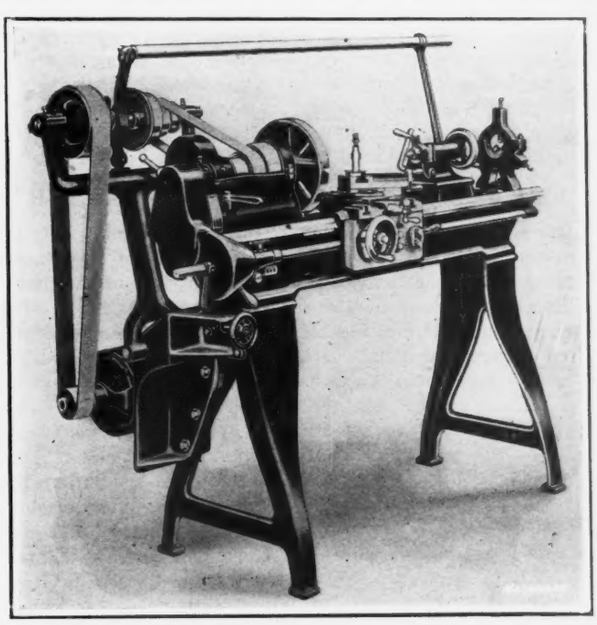
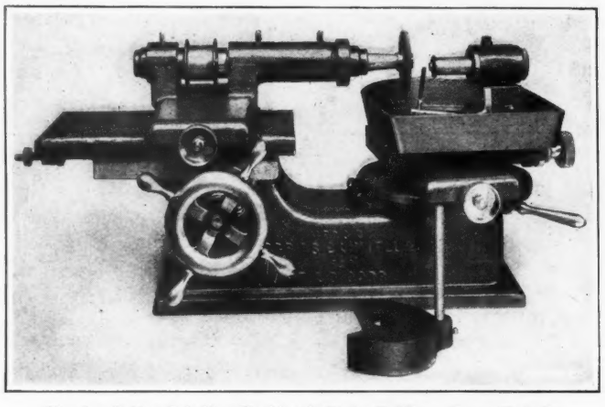


Fig 2. Shepard 12-inch Engine Lathe with Cone Head and Individual Motor Drive

which does away with separate change-gears and possesses many of the advantages of the complete quick-change lathe; also the reversing lever in the headstock, whereby the different feeds of the lathe may be instantly reversed without stopping the machine, shifting belts, or changing the direction of rotation. This mechanism is operated by a positive clutch and permits the lead-screw nut to remain in constant engagement when changing threads, making it unnecessary to reverse belts or watch a dial, thus greatly increasing the speed and decreasing the complexity of the operation.

This lathe is provided with six changes of spindle speed, ranging from 32 to 502 revolutions per minute, driven by a positive seven-jaw steel clutch. The changes in speed and shifting of the clutch are easily and readily accomplished by means of two levers conveniently situated. All clutches, clutch gears, and smaller gears are made of steel. The face of the headstock gears is 13/16 inch in width. The hollow spindle is made from 0.50 carbon steel and ground with a 1-inch hole, permitting the use of a draw-in attachment and collets. The spindle runs in phosphor-bronze bearings. The carriage has exceptionally large bearings on the bed; and the compound rest has an unusually large bearing surface to insure rigidity of the cutting tool. The compound rest is also gibbed and graduated. The tailstock is of the offset type, with an extra long bearing on the bed, and with provision for setting it over to allow for turning tapers. The bed is of deep section, designed for rigid construction under heavy cuts. The weight of the lathe is from 800 to 900 pounds net, according to the length of bed desired. This lathe is furnished with either bench or standard length legs.

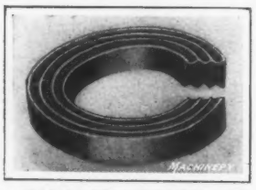
Another type of Shepard lathe is the 12-inch, cone-head, semi-quick-change screw-cutting engine lathe shown in Fig. 2, which is being made with either a regular double-friction countershaft drive or with an individual motor drive attachment, giving practically all the advantages of a geared-head lathe. This type of lathe also includes the special features of semi-quick-change attachment and the reversing mechanism operated by the reverse lever in the headstock. It also has an enclosed headstock, 0.50-carbon-steel spindle running in phosphor-bronze bearings, and a three-step cone pulley for two-inch belt. All other features of the design and attachments are the same as for the geared-head lathe. The cone-head lathe equipped for individual motor drive has a swinging arm supporting the countershaft, which, with the electric motor, is fastened to a bracket bolted to the lathe leg. This device puts the entire lathe and drive in one unit and supports the additional weight near the floor.



Circular Cutter Grinding Machine built by Robbins, Gamwell & Co.

SMITH & HEMENWAY LOCK-WASHER

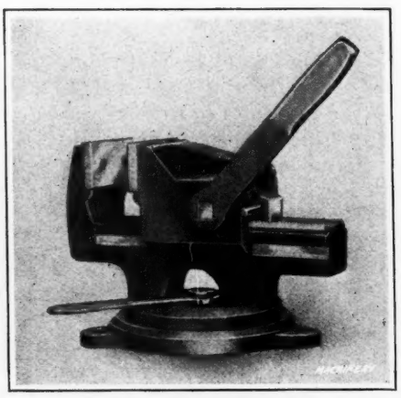
There are six points of contact—three engaging the nut and three engaging the under surface—on the "Red Devil" corrugated lock-washer which is the latest product of the Smith & Hemenway Co., Inc., 130 Coit St., Irvington, N. J. The washer is made of a special manganese steel, oil-tempered and given a gun-metal finish. It is claimed that this lock-washer is made to hold under the most extreme conditions of vibration. The washers are packed for sale in boxes of 100, 250, 500, and 1000. In addition, smaller boxes of assorted sizes are put up for the convenience of automobile owners. It is stated that one and one-fourth turn of the nut is required to loosen it from this lock-washer, so that it possesses exceptional holding power.



"Red Devil" Corrugated Lock-washer made by the Smith & Hemenway Co., Inc.

WINANS' VISE

The Barnett Foundry & Machine Co., Lyons Ave. and Coit St., Irvington, N. J., has just brought out a machinist's bench vise under the name of "Winans' New Idea" vise that embodies several interesting features. Reference to the illustration herewith presented will show its general characteristics. It will be seen that the screw and lever arrangement has been replaced by a pawl and rack. This is actuated by a handle on an eccentric shaft, which will exert ample pressure for holding the work. The adjustments from zero to maximum are made instantly with one sliding movement. The pawl eccentric and sliding jaw form a toggle joint, bringing the greatest pressure to bear on the top part of the jaws and causing the work to be clamped tightest at the working part. The moving member of the vise slides away from the operator and there is no handle between the operator and the vise. The gripping plates are hardened and ground, and the rack and pawl are also made of hardened steel. A feature of especial importance is that the whole vise may be removed from its swivel base and taken to a surface plate, or to a drilling or milling machine for continuous operations, since the base of the vise is accurately machined at right angles to the jaws. These vises are made with standard sizes of jaws from 3 to 8½ inches, and openings of 3½ to 12 inches. The whole design is such that it will stand up under the most trying conditions of service.



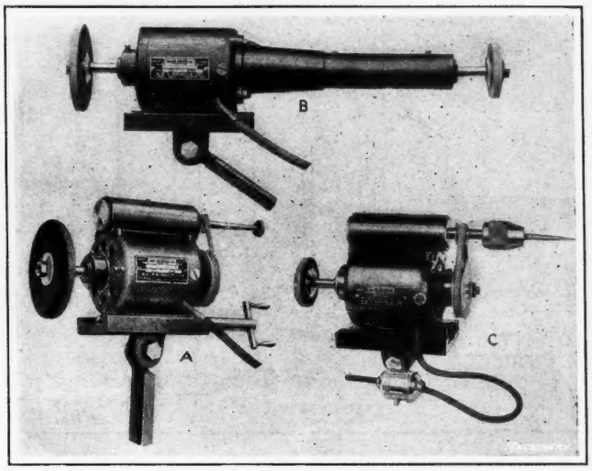
Winans' Vise made by the Barnett Foundry & Machine Co.

ROBBINS-GAMWELL CUTTER GRINDER

For use in grinding circular cutters, Robbins, Gamwell & Co., Pittsfield, Mass., have recently placed upon the market the machine which is illustrated and described herewith. It is especially suited for grinding convex and concave profile cutters and has a capacity for work up to 7 inches in diameter. In grinding convex cutters, true half circles can be ground on the periphery of cutters not less than 3 inches in diameter, and arcs of circles less than 180 degrees can be ground with a radius depending upon the diameter of the cutter, ranging from 1⅝ inch on a cutter 7 inches in diameter to ¼ inch on a cutter 2 inches in diameter. In grinding concave cutters, part of a circle slightly less than 180 degrees can be ground on a cutter not less than 3 inches in diameter. Attachments for grinding certain types of cutters that do not come within the capacity of the machine as regularly furnished, such as small cutters with large radii, can be supplied as extra equipment of the machine.

PRINGLE PORTABLE GRINDING MACHINES

R. E. T. Pringle, Ltd., 308-309 Tyrrell Bldg., Toronto, Canada, is now manufacturing what is known as the "Aro" portable electric grinding machine, which is made in a number of different types. One of these is a Type A universal machine, in which the motor runs at the correct speed on either alter-



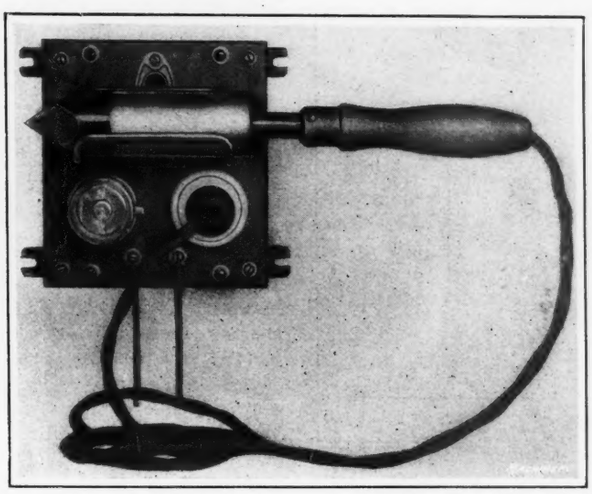
Types A, B, and C Portable Electric Grinding Machines made by R. E. T. Pringle, Ltd.

nating or direct current, giving a speed of 10,000 revolutions per minute on the main drive, and 30,000 revolutions per minute on the internal attachment. The motor and internal spindle are equipped with "Norma" adjustable ball bearings in order to reduce friction and wear to a minimum. The equipment furnished with this machine includes a set of grinding wheels and a cutter-grinder rest. The Type B machine is furnished with an extension arm 10 inches in length to adapt it for use in grinding deep holes where a light cut is to be taken at high speed. This is said to be an excellent machine for use in the tool-room for lapping dies, gages, etc. In addition to the internal spindle, this grinding machine is furnished with a larger grinding wheel for the performance of external operations. This wheel is 4½ inches in diameter by ⅜ inch face width, and the internal wheel is 2½ inches in diameter by ⅜ inch face width. A wheel of each of these sizes is furnished with the machine. The spindle of the Type C machine is driven at 40,000 revolutions per minute, which has been found to be the correct speed for grinding button dies and for chuck and small die work. This machine is furnished with a high-speed spindle provided with a chuck for carrying round carborundum sticks, and a second spindle for driving rubber grinding wheels. The equipment furnished with the machine includes two "Aro" rubber grinding wheels and two carbo sticks, ⅜ by 4 inches and ⅜ by 3 inches.

CUTLER-HAMMER RACK FOR ELECTRIC SOLDERING IRONS

Electric soldering irons which are left lying on a bench or other convenient place when not in use gather dirt and become a hazard. Often the tip will be overheated, necessitating refiling; the heating unit may also burn out, or the hot iron may set fire to the bench or other material. If the current is turned off, the iron cools down to such a degree that considerable delay is caused when the iron is again to be used. To overcome these objectionable features, the Cutler-Hammer Mfg. Co., Milwaukee, Wis., has recently developed an automatic soldering iron rack and control panel which decreases the amount of current taken by the iron when it is placed on the rack. This keeps the iron from overheating, prevents burn-outs, saves current, and encourages orderliness by providing a convenient connection point and support for the iron. The rack consists of a small slate panel, arranged for wall mounting, and carries a support for the iron which acts on the principle of the telephone receiver hook.

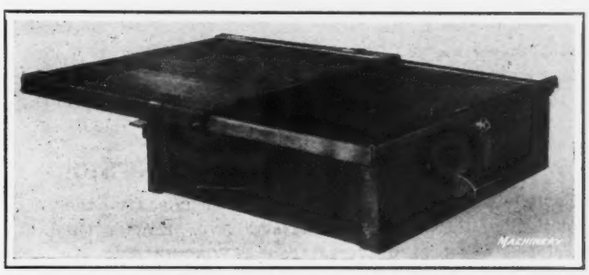
When the iron rests on the support or hook it bears the support down, and the resistance which is mounted on the back of the panel is inserted in the circuit with the iron. The current is reduced and the temperature held at a safe value, but ready for service and full current just as soon as the iron is lifted from the hook. Taking the weight from the hook disconnects the resistance for the soldering iron circuit and allows full current to flow. Below the hook, on the same panel, there is a push-button snap switch and a standard receptacle to which the plug of the soldering iron cord is connected. This little panel, therefore, is a complete switchboard, which may be mounted on the wall or machine within reach of the workman. When not in use and at night, the switch is snapped off, which completely opens the circuit to the iron. These automatic racks are designed for use with Cutler-Hammer soldering irons, but may be used with other similar types as well.



Cutler-Hammer Electric Soldering Iron Rack and Control Panel

NEW BRITAIN STEEL BENCH DRAWER

An all-steel bench drawer, which has recently been added to the line of shop furniture built by the New Britain Machine Co., New Britain, Conn., is designed to meet the requirements of shops that want a practically indestructible drawer. A seam of triple thickness runs around the upper edge, and all joints in the steel are welded to provide ample strength and durability. In a commonly used type of bench, a thinner back plank is used than the one at the front, leaving an open space between the back plank and the ordinary type of drawer, which affords a possibility of reaching into the drawer from the back by those who are not provided with a key. In the New Britain steel bench drawer, a solid sheet-metal top makes it impossible to take things out at the rear, and also prevents blocking the drawer through wedging its contents against the under side of the bench. This sheet-metal top also excludes any oil or water which may soak through the top of the bench. The slideways are always integral with the top of the drawer, giving a smooth, free movement without tendency to bind or cramp. The handle is of generous size, and so shaped that it is comfortable to hold. The drawer is provided with a cylinder lock and two individual keys. If desired, a master key may be provided at extra cost, and attention is called to the fact that possession of a master key by the foreman will prevent men from stowing contraband materials in bench drawers. Drawers of this type may be easily and quickly installed without requiring the bench to be cut. It is simply necessary to remove the two stops and pull the drawer completely out from the slideways. After fasten-

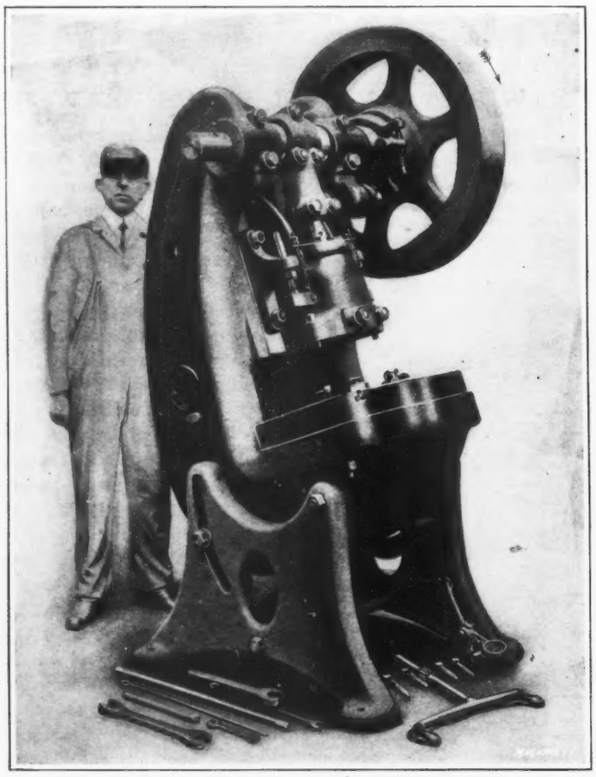


Steel Bench Drawer made by the New Britain Machine Co.

ing the top to the under side of the bench with wood screws, the draw is inserted and the stops are replaced. The principal inside dimensions of these drawers are: 18 inches long by 16 inches front to back, by 5 inches deep; over-all dimensions are 19 inches long by 16½ inches front to back, by 5¾ inches deep; and the weight, packed for shipment, is 40 pounds.

FERRACUTE SINGLE-ACTION PRESS

The Ferracute Machine Co., Bridgeton, N. J., is placing a new series of single-action presses on the market, the accompanying illustration representing the fourth size in this series. These presses have the general characteristics of similar machines previously built by this company, but are heavier and contain longer ram bearings. The shaft may more easily and quickly be removed than in other types of such presses. Each shaft-cap is clamped to the frame by two bolts which are of unusually large size and equal in strength



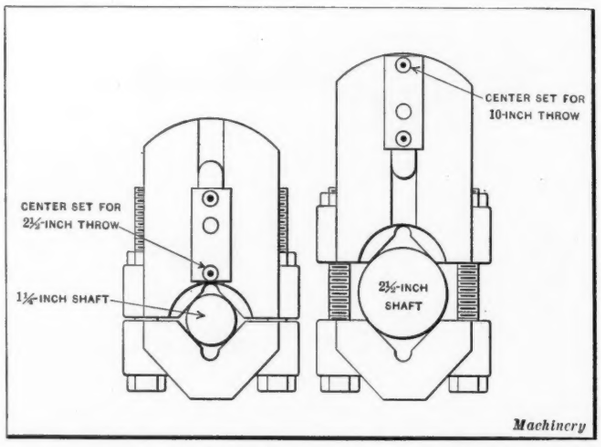
Single-action Press built in Six Sizes by the Ferracute Machine Co.

to the four bolts often used. The pitman-strap is removable in separate halves, and a new form of ram knock-out is also used, but this is omitted unless specially ordered.

The press is shown partially inclined. It may be completely inclined or raised to an upright position by an elevating attachment, operated at the back of the press by the two-handled wrench shown on the floor. Presses of the same size and construction are also built with gearing instead of a flywheel. This machine exerts a pressure of 35 tons and weighs 4700 pounds. Some of the dimensions are as follows: Stroke of ram, 2 inches; adjustment of ram, 3 inches; opening through back, 17 inches wide by 11 inches high; depth of throat from center of ram back to frame, 9 inches; height from bed to ram at top of stroke and adjustment, 10½ inches. The flywheel has a diameter of 35 inches, width of 6 inches, and weight of 750 pounds. The diameter of the steel shaft at the journals is 3½ inches and at the crank, 4¼ inches.

SALTER CRANKSHAFT CENTERS

For use in turning the bearings on crankshafts, the Salter Motor Mfg. Co., 1516-1518 Oakland Ave., Kansas City, Mo., developed a set of universal centers for its own use. The centers are adapted for turning one-cylinder, two-cylinder,

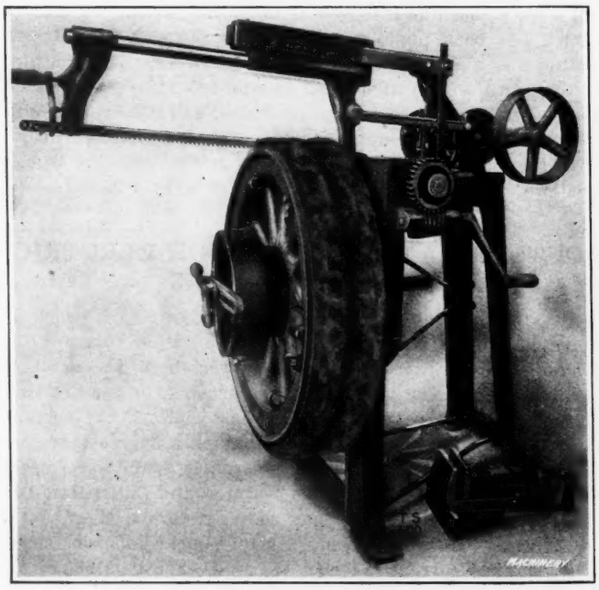


Centers made by Salter Motor Mfg. Co. for Use in refinishing Crankshaft Bearings

four-cylinder, or six-cylinder crankshafts, and they will fit any shaft from 1⅛ inch to 2½ inches in diameter, and turn any throw from a 2½-inch crank to a 10-inch crank. These centers proved so successful in operation that recently a decision was reached to make them for the market. They are especially adapted for use in garages where machines are sent in that require the crankshaft bearings to be trued up in order to enable the engine to run quietly and efficiently.

ROBERTSON HACKSAW FOR TIRE RIMS

For use in cutting old tire rims of any size from 30 to 40 inches in diameter, the W. Robertson Machine & Foundry Co., 56-58 Rano St., Buffalo, N. Y., has placed on the market the No. 600 hacksaw machine which is here illustrated. This machine is adapted for cutting the steel rims supporting the rubber on truck tires. When new, these tires are placed onto the wheel rim with a hydraulic pressure of from 30 to 50 tons, and after the wheel has been used, rust and corrosion occur between the wheel rim and the tire rim, thereby uniting the metals to such an extent that it is often impossible to remove the tire rim from the wheel. To facilitate cutting the rims of these truck tires, a special frame was designed with worm-gearing employed to raise the wheel to the proper height. Very little effort is required to raise a thousand pounds, and one man can take care of the work of cutting a rim of the maximum size. The machine cuts on the draw stroke and lifts the frame on the return stroke, this being accomplished by an oil compression lift pump. The saw frame has a capacity for blades from 12 to 24 inches in length and will cut

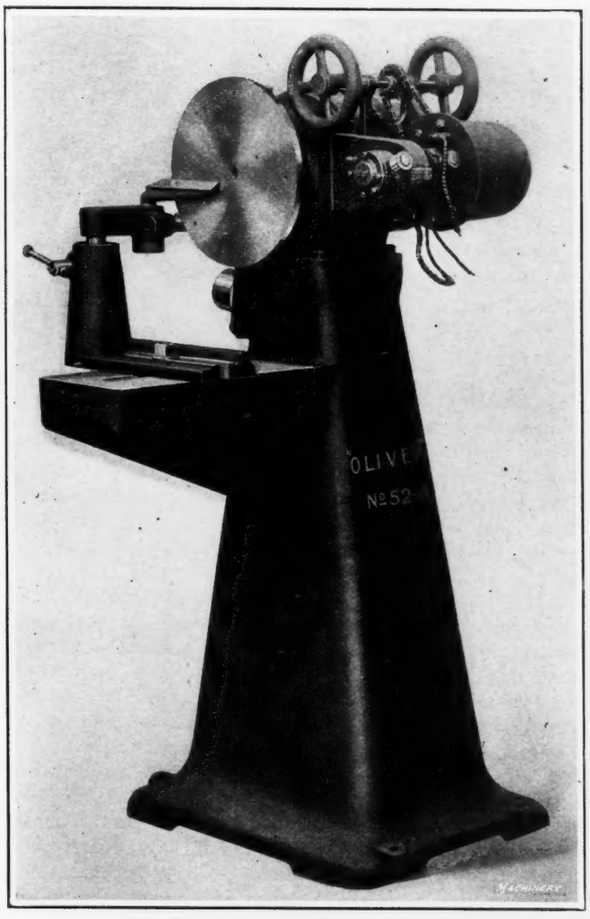


No. 600 Power Hacksaw Machine built by the W. Robertson Machine & Foundry Co.

rims on dual tires up to 16 inches in width. Either belt or motor drive may be provided. The machine occupies a floor space 36 by 66 inches in size; the height of the blade when the cut is completed is 40⅛ inches; the over-all height of the machine is 55 inches; and its net weight is 590 pounds.

OLIVER FACE LATHE

In the accompanying illustration there is shown a motor-driven face lathe which is one of the recent products of the Oliver Machinery Co., Grand Rapids, Mich. This machine is self-contained, the motor-driven head, controller or switch, and rests being mounted on a floor column, making the machine especially desirable for use as a portable face lathe. All electrical parts are totally enclosed to exclude dust and provide for the safety of the operator. This lathe swings 24 inches over the bracket, 20 inches over the rest socket, and will turn work up to 12 inches wide by 20 inches in diameter, or up to

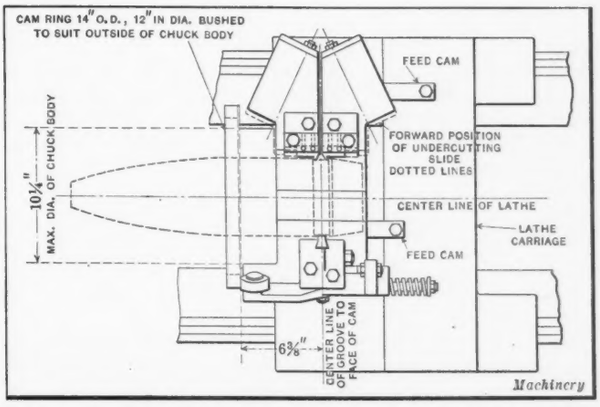


Face Lathe built by the Oliver Machinery Co.

6 inches wide by 24 inches in diameter. The equipment furnished with the machine includes a 16-inch tool-rest with an offset rest-holder, a right-angle rest, a 6-inch faceplate, a 12-inch faceplate, and a 2¼-inch screw chuck. A motor head may be provided for use on this machine equipped with an alternating-current motor to run from 800 to 3500 revolutions per minute, the speed being controlled by handwheels which govern a self-contained controller. A direct-current motor for the head may also be provided to run at from 600 to 3000 revolutions per minute, with the speed controlled by a controller mounted on the floor column.

GRAY WAVING AND UNDER-CUTTING ATTACHMENT

An attachment is now built by the Gray Machine Tool Co., Inc., 2661 Main St., Buffalo, N. Y., for use in waving and undercutting the copper band groove on all sizes of shells. This attachment is built in different sizes for handling various shells, although it is usually employed on shells from 4½ to

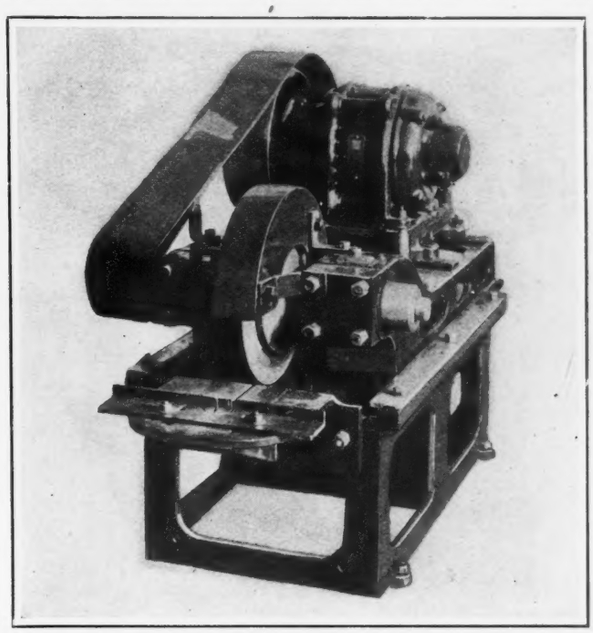

CAM RING 14" O.D., 12" IN DIA. BUSHED TO SUIT OUTSIDE OF CHUCK BODY
FEED CAM
FORWARD POSITION OF UNDERCUTTING SLIDE DOTTED LINES
10¼" MAX. DIA. OF CHUCK BODY
CENTER LINE OF LATHE
LATHE CARRIAGE
FEED CAM
6⅜"
CENTER LINE OF GROOVE TO FACE OF CAM
Machinery

Under-cutting and Waving Attachment for 6-inch and 155-millimeter High-explosive Shells made by the Gray Machine Tool Co., Inc.

6 inches in diameter; on larger shells complete machines are usually employed. Where the attachment is used, it is made to fit any standard lathe of dimensions suitable for the operation. The shell should be held in an air-operated collet chuck, although it may be satisfactorily supported in other ways, as by a threaded nut in the fuse hole in the nose and the tailstock center, and driving with a clamp or dog. Such a method of holding is slower than where an air-operated collet is employed. The main body of the attachment is clamped to the lathe bed and on this casting are placed the waving slide and two under-cutting slides through which run hardened steel cam-bars that are bolted to the carriage at one end. On the slides are bolted the waving and under-cutting tool-blocks made of machinery steel, that hold the high-speed steel tools. As the carriage feeds along, the cam-bars force the slides and tools in to the depth set for the cut, and when the high spot is reached the slides recede. The waving and under-cutting tools are automatically brought into the work at the same time, the under-cutting tools being a few thousandths ahead of the waving tool. The wave is produced by a roller, held on a bracket from the waving slide and against a hardened steel cam-ring which is bolted to the face of the chuck. This waving cam ring is machine-cut from a master cam.

POND-ROBINSON METAL-CUTTING SAW

The Pond-Robinson Metal Saw Co., Ltd., 1204 Howard St., San Francisco, Cal., is now building a metal-cutting saw for which the following advantages are claimed: The blades have a long operating life and are capable of cutting hard metals without requiring the use of a cutting fluid or coolant. The

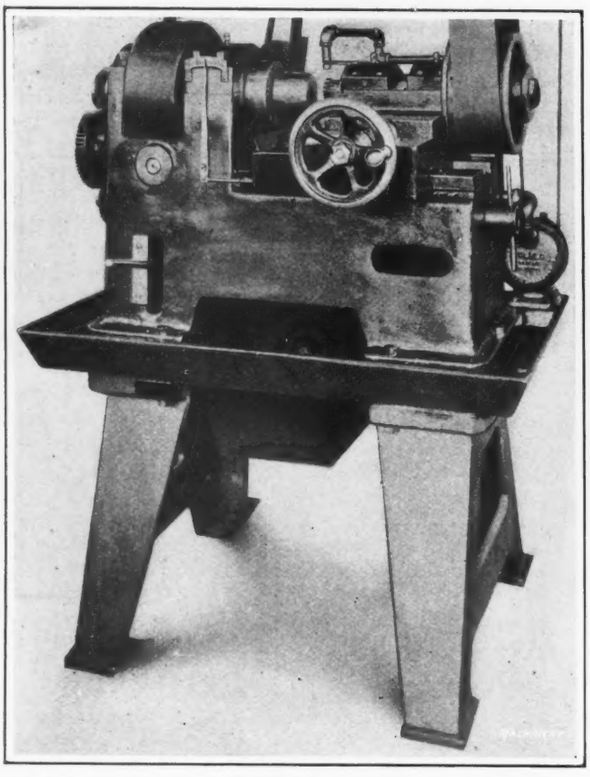


Pond-Robinson Metal-cutting Saw equipped with Improved Type of Circular Saw Blade

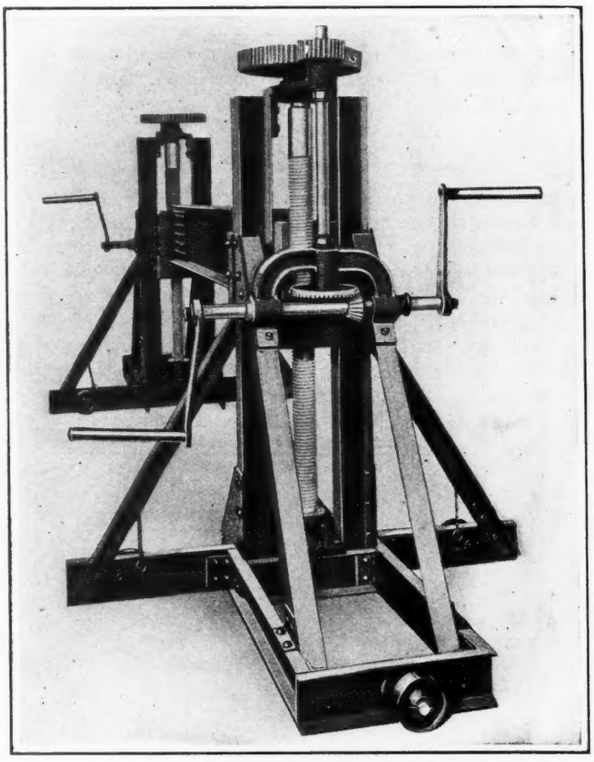
blade is mounted between bearings and ample cutting power is provided. The saw cuts rapidly and is particularly well suited for use in cutting tubes, pipe, and similar material. Saw blades are made with the cutting edge somewhat wider than the remainder of the blade, thus affording clearance, and the teeth are so formed that in cutting tubing, pipe, etc., there is no danger of their being broken off. The blade is made of steel and heat-treated by a process which makes the rim and teeth very hard. It is claimed that the saw will cut all kinds of hard steel, stellite, etc., without the necessity of annealing. Machines equipped with saws 36 inches in diameter and over are provided with air-feed cylinders. An idea of the rate at which cutting can be done will be gathered from the fact that channels ranging in size from 0 to 10 inches and tubes 6 inches in diameter can be cut in from three to ten seconds. The machines are built in four different sizes, known as Nos. 1 to 4, inclusive, and they are equipped with saws 18, 24, 36, and 48 inches in diameter, respectively. The No. 1 machine occupies a floor space 2 by 4 feet in size and weighs 600 pounds; it has a capacity for cutting steel shapes or tubes up to 2 inches and solid bars up to ¾ inch. The No. 2 machine occupies a floor space 3 by 4 feet in size and weighs 1000 pounds; it has a capacity for cutting tubes and shapes up to 3 inches, and solid bars up to 1¼ inch. The No. 3 machine occupies a floor space 3½ by 7½ feet in size and weighs 3500 pounds; it has a capacity for cutting tubes and shapes up to 6 inches, channels up to 10 inches, and solid bars up to 1½ inch. The No. 4 machine occupies a floor space 4 by 8 feet in size and weighs 5000 pounds; it has a capacity for cutting 90-pound steel rails, 18-inch channels, and 15-inch I-beams.

WOODS THREAD MILLING MACHINE

The Woods Engineering Co., Alliance, Ohio, is now building a small thread milling machine for threading shell plugs. This type of machine was developed to meet the requirements of a contractor engaged in the production of plugs for the United States Government, who was unable to procure equipment for threading the plugs. In addition to this special work, the machine is adapted for many other thread milling operations. It is interesting to note that this machine was designed and built within three weeks of the date on which the order was received.



Thread Milling Machine built by Woods Engineering Co. for threading Shell Plugs



Portable Crane built by Fox Bros. & Co. for Use in Shops where a Traveling Crane is not Available

FOX PORTABLE SHOP CRANE

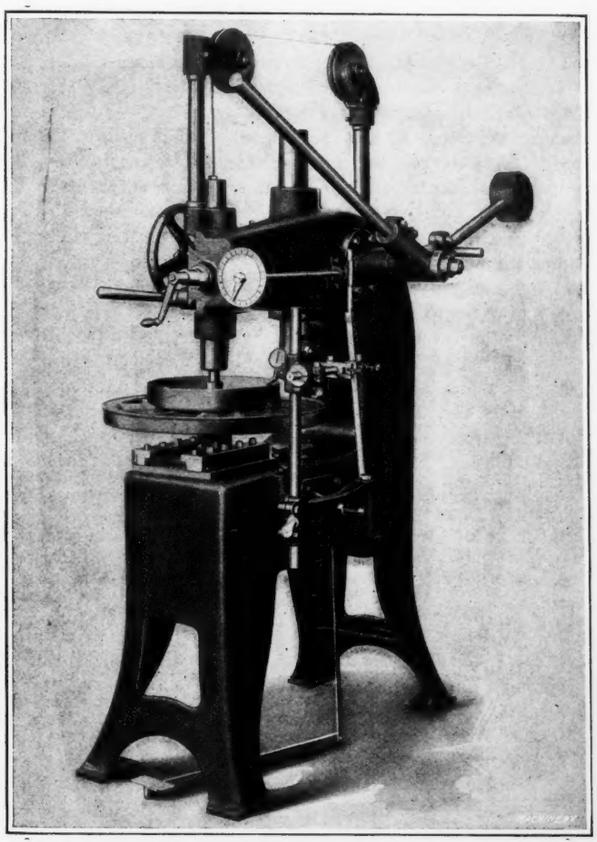
To meet the requirements of railroad shops and other plants where an overhead traveling crane is not provided, Fox Bros. & Co., 126-130 Lafayette St., New York City, have placed on the market the portable shop crane here illustrated and described. The complete outfit consists of four separate jacks and two cross-girders. Each jack is operated by a pair of handles so arranged that either two or four men can operate two jacks at the same time. In the case of light loads the handles are so balanced that one man can operate a jack. Each jack is mounted on cast-iron wheels with flat treads, so that they can be moved from place to place with little effort. These wheels revolve on shafts attached to eccentric bearings, so that when the jacks are in position pins are removed from the bearings, allowing the wheels to rise and the entire base of the jack to rest on the shop floor. The framework is built of structural steel shapes with the members strongly riveted together with gusset plates. Particular attention has been paid to the design of this equipment with reference to rough usage, all members having been made of ample strength so that they are capable of standing up under severe conditions of service. The crane has a working capacity of 60 tons, although each crane is actually tested under a load of 75 tons.

BLOMQUIST-ECK WHEEL INSPECTION AND TRUING MACHINE

A machine especially intended for inspecting and truing automobile wheels has been brought out by the Blomquist-Eck Machine Co., 1146 E. 152nd St., Cleveland, Ohio. This machine is provided with an indicator that shows whether the wooden automobile wheel is out of true sidewise, and whether the pressed steel brake-drum attached to the wheel is true on the inside and outside diameters, and on the rim or edge. The machine also has provision for correcting the errors of the wooden wheel that may be shown by the indicator. An arbor is held in the spindle at the top and is guided in a bushing at the bottom. On this arbor, and also on the guiding bushing, there are mounted rings, which, in turn, fit the bore of the wheel. These rings are free to revolve, so that the automobile wheel, when mounted upon them, can be turned by hand. When mounting the wheel in the machine, the operator puts

his foot on the treadle shown, which withdraws the small plug bearing against the under side of the wheel rim. After mounting, he locks the spindle in position by the straight lever at the left.

When the wheel is locked in place, as far as vertical motion is concerned, the small plug bearing against the lower side of the wheel rim is permitted to come into contact with the rim by the pressure on the foot-treadle being released. A counterweight then presses the plug up against the rim, and keeps it in contact throughout the test. The plug is connected by levers with the large indicator dial shown, so that, as the operator revolves the wheel by hand, any sidewise irregularities of the rim will be indicated on the dial. While rotating the wheel, the operator keeps his eyes on the dial, and then operates the long lever that is connected by a gear and rack to the ram, which, when brought down upon the side of the wheel that is high, corrects the error by bending the wheel rim straight. In case the wheel rim needs to be pushed up instead of being bent down, the lift attachment, provided with a hook and mounted on the end of the ram, is brought into use. The spindle is mounted on an arm, and made adjustable along this arm in order to provide for different diameters of wheels. The slide on the table is provided for the same purpose, as the ram is always in the same position and must come over the wheel rim. The brake-drum is inspected in the same machine by bringing up against it a swinging arm on which is mounted an Ames indicator. In this way the truth of the inside cylindrical surface, the outside surface, and the edge of the brake-drum are tested. If they are found to be out of true more than is permissible, the drum is removed and trued up by suitable means in another machine.



Wheel Inspection and Truing Machine built by the Blomquist-Eck Machine Co.

LAFAYETTE THREAD-TOOL GRINDING FIXTURE

The thread-tool grinding fixture here illustrated was recently developed by the Lafayette Tool Works, 176 Worth St., New York City, for use in grinding thread-cutting tools of any angle from the 29-degree Acme thread to the 60-degree U. S. standard. The fixture consists of a cast-iron body in which there is a 5/16-inch square hole, provided for holding the tool to be ground. A set-screw is provided for tightening down onto the tool, which may be of either square or round stock. There are two hinged bases held inward against an adjustable wedge by a single coiled spring. These bases are hinged on two taper pins which provide for slight wear. The wedge is adjustable in and out along a line parallel with the center line of the tool to be ground. By turning the double slotted screw, the adjusting wedge is operated in and out, thereby throwing the hinged bases inward and outward on their pivots, causing them to form various angles with the center line of the fixture. This wedge is graduated with a neutral mark and the base is graduated by degrees from 29 to 60.

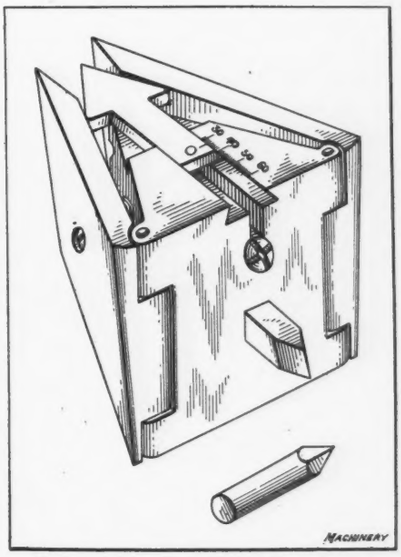


Fig. 1. Close View of Thread-tool Grinding Fixture, showing Arrangement of Mechanism

The clearance angle on the tool is automatically provided for by the hinged bases being set off at 15 degrees in the correct direction for producing clearance on the tool. This tool not only takes the place of the three solid blocks that would be required for the Acme 29-degree, Whitworth 55-degree, and U. S. standard 60-degree thread, but may be quickly adjusted to any of the angles in between, such as 46 and 47, which are often used in gage-making for grinding a tool that is to cut a thread that is afterward to be ground to 60 degrees. While the fixture is graduated only in degrees, minutes and seconds may be set upon it by a toolmaker's protractor. The device is cast iron, except the wedge, which is cold-rolled steel, hardened,

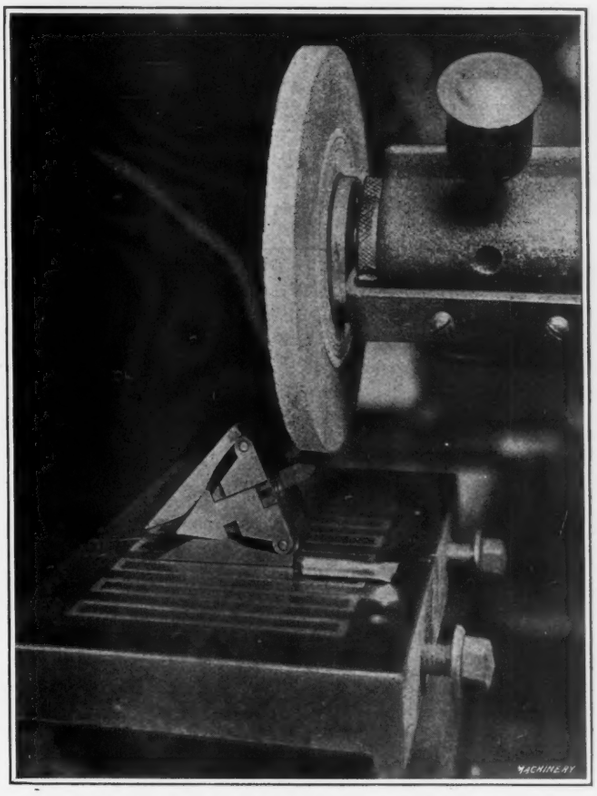
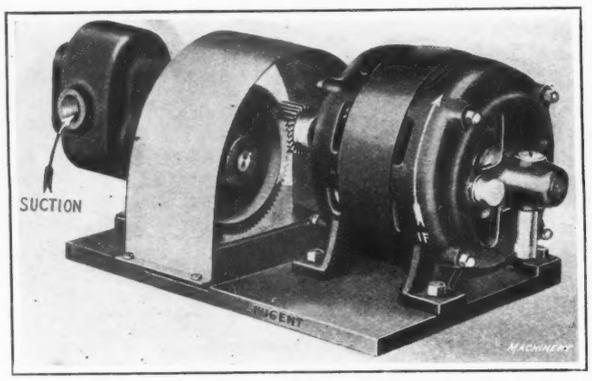


Fig. 2. Universal Thread-tool Grinding Fixture made by the Lafayette Tool Works

NUGENT MOTOR-DRIVEN OIL PUMP

William W. Nugent & Co., Chicago, Ill., have developed a geared, motor-driven rotary oil pump for oiling systems and for pumping oil from a barrel to an overhead reservoir. Two sizes are obtainable, having a delivery of eight quarts per minute and forty quarts per minute at 500 revolutions per minute. Power is furnished through a noiseless rawhide pinion from a fractional horsepower motor made by the General Electric Co., Schenectady, N. Y., for the prevailing current. The motor is controlled through a rheostat and switch box mounted in a convenient location.



Motor-driven Oil Pump built by William W. Nugent & Co.

ALTERNATING-CURRENT ARC-WELDING MACHINE

It is rather a general impression among users of arc-welding machines that satisfactory results can only be obtained where direct current is used for operating the equipment. Despite this fact, the Arcwell Corporation, 42 Broadway, New York City, has placed on the market an apparatus in which alternating current is successfully used for arc-welding. Under ideal conditions of operation, the length of arc used for welding should be approximately 1/16 inch, but it is impossible for even the most experienced welders to continue to hold their hands steady enough to maintain the desired uniformity in the length of the arc. Ordinarily, where alternating current is used, the arc will be broken whenever the welder's hand moves sufficiently so that its length is considerably in excess of 1/16 inch. If the arc is broken, it is necessary to bring the welding electrode into contact with the work to be welded and then to draw it away in order to re-establish a fresh arc, after which welding can be continued until the arc is once more broken. In standard forms of equipment using direct current, slight variations in the length of arc do not result in trouble of this kind.

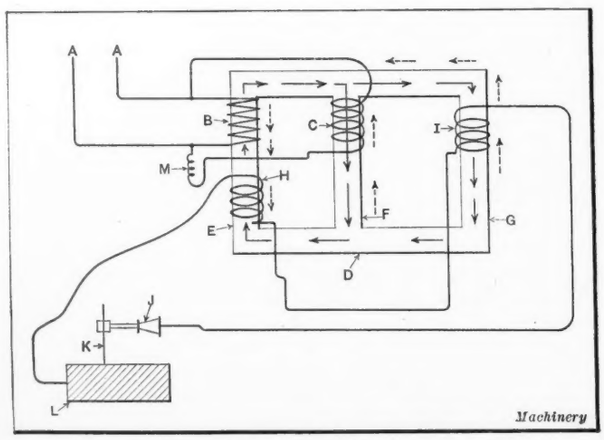


Fig. 2. Diagram showing Arrangement of Transformer Windings

In the apparatus built by the Arcwell Corporation, where alternating current is used for arc-welding, a special form of transformer is contained in the case illustrated in Fig. 1. This cuts down the voltage from 220 to approximately 80 volts on open circuit; while welding, the potential across the arc is less than 25 volts. So far as the method of procedure is concerned, there is nothing unusual about the machine. The apparatus is connected to an ordinary power switchboard or service and Swedish iron wire is used for the welding electrode. In Fig. 1, the operator is shown at work repairing a cracked hub of a pulley.

An arrangement of transformer windings has been developed, which keeps the temperature of the arc constant, even though the operator's hand wavers. As a result, the weld produced by the machine is soft, strong, and ductile. The theory of operation of the transformer will be readily understood by referring to Fig. 2 while reading the following description. At *A* there are shown the terminals where connection is made with a source of alternating-current power, and the main primary winding of the transformer is shown at *B*, while the auxiliary primary winding is shown at *C*. There is an iron core *D* consisting of three legs *E*, *F*, and *G*, and the main secondary winding is shown at *H*, while the auxiliary secondary winding is indicated at *I*. The electrode holder in which a piece of Swedish iron wire is carried will be seen at *K*, and the work to be welded is indicated at *L*. Coil *M* is simply a retarding inductance. Primary coil *B* sends magnetic flux through the cores in main primary winding *B* and auxiliary primary winding *C*, and core *G* in the direction indicated by heavy arrows. As a result, when electrode wire *K* touches the work *L* current flows through the secondary windings *H* and *I*. Flux produced by these two windings is sent in the direction indicated by dotted arrows. Under a light load, the auxiliary primary winding *C* prevents the primary flux from entering core *F*, but under a heavy load the secondary flux becomes strong enough to overcome the effect of primary winding *C*; in other words, the transformer can be short-circuited without damage. Arcwell electric arc-welding machines are built in 75-, 150-, 300-, 400-, and 600-ampere sizes. The 150-ampere size, which is best suited for average classes of service, has leads brought out for welding at 75, 100, 125, and 150 amperes. A cutting lead is also brought out to provide for the rapid performance of cutting operations at 200 amperes.

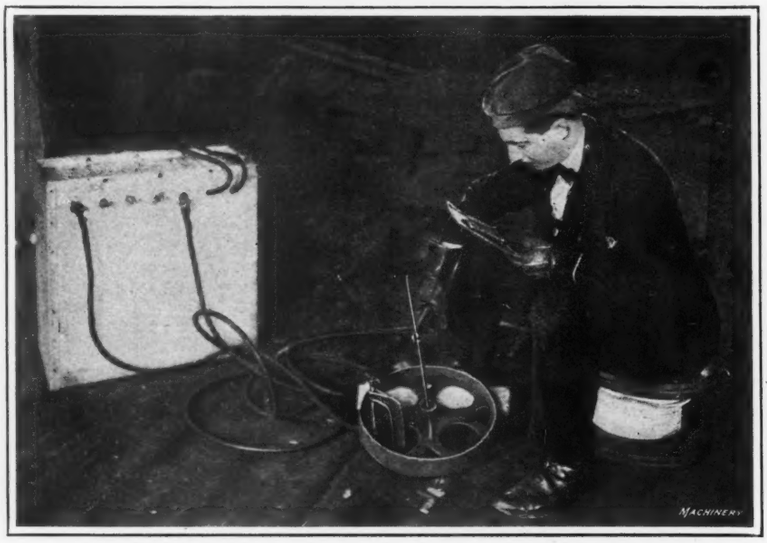
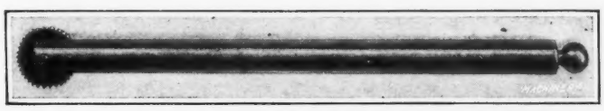


Fig. 1. Alternating-current Arc-welding Machine built by the Arcwell Corporation

"SECTOSTYLE" FOR CROSS-SECTIONING

To facilitate the work of drawing evenly spaced cross-section lines on drawings, the American Sales Co., 311 W. 59th St., New

York City, has recently placed on the market an instrument known as the "Sectostyle." It consists of a handle carrying a pivoted toothed wheel which the draftsman impresses into the paper where cross-section lines have to be drawn. As this wheel is rolled over the paper it marks spaces which indicate the points at which section lines should be drawn, thus improving the appearance of the drawing by making the lines regularly spaced. The instrument is held in the same



"Sectostyle" made by the American Sales Co. for cross-sectioning Drawings

way as a pencil and the wheel is moved along the edge of the T-square or triangle. Various effects in the spacing of section lines may be obtained by skipping alternate marks laid out by the "Sectostyle," etc. This instrument is very simple to use and enables inexperienced draftsmen to produce cross-sectioning of good appearance rapidly.

NEW MACHINERY AND TOOLS NOTES

Belt Dressing Distributor: Improved Surface Mfg. Co., North Tonawanda, N. Y. A cylindrical tin with rubber cushion contact for a speeding belt and lineal regulator to keep the material in condition.

Countersink: Standard Tool Co., Cleveland, Ohio. A countersink especially designed for countersinking holes in ship plates. This tool is made in two styles with spiral or straight flutes and has three cutting lips. It is made of high-speed steel.

Forming Hammer: C. M. Yoder Co., Engineer's Bldg., Cleveland, Ohio. A power hammer designed for use in forming and planishing various shapes of sheet metal, such as automobile bodies, hoods, cowls, and other curved sheet-metal products. This hammer is built in several sizes to meet the requirements of diversified classes of work.

Bevel Knife Grinding Machine: Machinery Co. of America, Grand Rapids, Mich. A bevel grinding machine for use on circular knives, cutters, and similar shaped work, ranging from 3 to 20 inches in diameter. This machine is suitable for grinding or sharpening the circular cutters or knives commonly used for cutting paper, cork, cloth, and similar substances.

Planing Machine: Bickett Machine & Mfg. Co., Cincinnati, Ohio. This company is now building an improved line of planers of extremely rigid construction which are made in the following sizes: 36 by 36 heavy, 42 by 36 heavy widened, 44 by 36 heavy widened, 42 by 42 both standard and heavy, 48 by 42 heavy widened, 52 by 42 heavy widened, and 44 by 44 standard.

Shell-nosing Attachment: R. J. Whelan, 328 Fourth St., Elyria, Ohio. An attachment designed for use on any standard steam or air hammer or any mechanical forging press in which the lower is the fixed die and the upper the movable one. This device is built for handling forgings for the following sizes of shells: 4.7-inch, 155-millimeter, 8-inch, and 240-millimeter.

Industrial Truck: Cowan Truck Co., 88 Water St., Holyoke, Mass. An elevating truck provided with an improved locking device which consists of a mechanism designed principally to prevent the load from becoming unseated when the truck is being drawn over uneven floors. Trucks of this type are built in various sizes, with load-carrying capacities ranging from 1000 to 3000 pounds.

Grinding and Boring Attachment: Nelson Tool Co., 1605 W. Lake St., Chicago, Ill. A combination boring-bar and grinding wheel attachment for use on lathes and shapers. This device is placed over the toolpost and is held by means of the regular toolpost screw which is tightened down upon a bar slipped through the hole. An adjustment provides for raising or lowering the bar or wheel to any required position.

Journal and Axle Lathe: Niles-Bement-Pond Co., 111 Broadway, New York City. This machine provides for turning car wheel journals without removing the wheels from the axle. It is a combination journal turning and axle lathe for machining the inside and outside journals on axles of the center-drive type. The upper portions of the bed are capable of contraction to form gaps which will clear wheels mounted on the axle.

Bench Furnace: Johnson Gas Appliance Co., Cedar Rapids, Iowa. A bench furnace adapted for heating small parts. This is known as a No. 108 furnace and gas is used for fuel. A work-rest block is furnished and a baffle plate partially closes the mouth of the furnace. These features, together with the angle of the burners and curved shape of the hood are said to enable the furnace to give very uniform results in heating the work.

Shell Lathe: Buffalo-Pitts Co., 4th and Carolina Sts., Buffalo, N. Y. A machine which provides for the performance of three operations at a single setting of the work. The functions of the machine are to cut off the open end of the shell forgings to a predetermined length from the inside of the base, to drill a centering socket in the outer surface of the base, and to face off the outer surface, giving a predetermined thickness of the base.

Rifling Machine: J. N. Lapointe Co., New London, Conn. A machine developed for use in broaching the rifling in one-pounder gun barrels. Two operations are required to complete the rifling operation, roughing and finishing broaches being employed for the respective operations. The length of the rifled section in these gun barrels is 44 inches and there are twelve helical grooves approximately 0.015 inch deep which make one complete turn in 40 inches.

Power Presses: Moore & Co., Grand Ave. and Franklin St., Chicago, Ill. These machines are designed with an exceptionally large die-bed and ample lift of the ram. These features allow the use of large dies for comparatively light work that would otherwise have to be done on punch presses of considerably greater capacity. These new additions to the line of presses built by Moore & Co. include a No. 4 punch press, a No. 2 screw press, and a No. 3 inclinable punch press.

Belt Fastener: W. O. & M. W. Talcott, 91 Savin St., Providence, R. I. Two types of belt fasteners, one of which is known as the "Ideal" and is used on rubber, canvas, balata, and textile belts. This fastener is used between the layers of the belt or on the side away from the pulley. The fastener is secured to the belt by means of rivets. The other type of fastener is known as "Acme" steel belt hook and is adapted for use in fastening leather, rubber, or canvas belts.

Filing Machine: Barry Mfg. Co., 5-11 E. Kinzie St., Chicago, Ill. This machine is made in two sizes which are designated as Nos. 2 and 3. They are provided with a file holder that permits the use of any regular or special file with either a straight or tapered shank. Jig-saw or hacksaw blades can also be accommodated. The table is adjustable in four ways to give any angle or clearance required on the work, and indicator scales and needles facilitate accurate adjustment.

Drilling, Boring, and Tapping Machine: Rockford Drilling Machine Co., Rockford, Ill. A combination horizontal drilling, boring, and tapping machine which is especially designed for use on large parts where the regular table cannot be used to advantage. This machine has vertical and horizontal movements of the head and column, which permit the spindle to work over an area 18 inches high by 36 inches long. Floor plates and work-tables can be furnished with the machine to meet the customer's specifications.

Stud Driver: Giern & Anholtt, 33-43 St. Aubin Ave., Detroit, Mich. With this tool the stud is screwed into a tubular portion held by means of an inclined slot in the tube working on a pin in the handle. Due to the action of screwing the stud into place, the handle is advanced by means of this slot and pin, and firmly holds the stud. When the motion is reversed, the pin moves in the slot and releases the pressure on the stud, thus allowing the driver to be easily unscrewed without disturbing the position of the stud.

Grease Cup: Dawson Mfg. Co., 4928 Broadway, Chicago, Ill. A line of grease cups which comprises a number of different styles. A feature of the design is that it has been worked out in such a way that a device is provided which prevents the cap of the cup from unscrewing due to vibration. Another feature is that assurance is provided that the cap will be lined up properly when it is screwed into place without danger of damaging the threads. These cups are made in six styles with inside diameters ranging from 13/16 to 1¼ inch.

Fluid Pressure Governor: General Electric Co., Schenectady, N. Y. A pressure governor adapted for use on gas and liquid systems where it is important to maintain the pressure fairly constant. This governor is so designed that it provides for maintaining pressure between certain predetermined limits, starting or stopping the motor-operated pumps or compressors as may be required. Governors of this type are made with rated capacities for pressures of 80, 100, 160, 300, or 500 pounds and operate within settings of from 3 to 12 pounds between the high and low pressures.

Electrical Switch: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. A switch designed with no exposed live parts, which is used as a substitute for the ordinary knife switch. The current carrying parts and fuses of this safety switch are enclosed in a steel box, and the circuit is opened and closed by a toggle type of operating mechanism. The cover of the box that contains the switch is divided into two parts, one of which forms a permanent covering for the switch while the other part is hinged to swing back, thus permitting renewal of the fuses.

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

At the spring meeting of the American Society of Mechanical Engineers, held in Worcester, Mass., June 4 to 7, a number of valuable papers and reports were presented. Among the latter, the most important was the report of the Committee on Screw Thread Tolerances, part of which is abstracted elsewhere in this number of MACHINERY. A report of the Committee on Weights and Measures was also presented, consisting almost entirely of a reprint of the report entitled "The Metric System in Export Trade," made by F. A. Halsey to the American Institute of Weights and Measures, an organization that has for its main object the maintenance of the English system of weights and measures in the United States.

This report is based upon more than a thousand answers to a questionnaire which was sent to several thousand manufacturing concerns in the United States, some or all of whose products are shipped to countries where the metric system is in use. The conclusion of this report is that the export trade in the United States is mainly conducted in the English system of measurements. Eighty-two per cent of the exporters to countries using the metric system do not use this system in their production, while 14 per cent use it partially, and 0.4 per cent exclusively. Between 3 and 4 per cent of the manufacturers did not reply to this question. Only 1.6 per cent of American exporters that replied to the questions put to them by the American Institute of Weights and Measures use the metric system in response to a commercial need, and 38 per cent make some use of it in shipments, because compelled to do so by the laws of foreign countries.

A report was also presented by the Committee on Steel Roller Chains, this committee having cooperated with a committee of the Society of Automotive Engineers. This report recommends mainly retaining the standards already in use by various manufacturers.

Standards of Graphic Presentation

A report was presented by the Committee on Standards of Graphic Presentation, to which a number of associations of national scope have appointed representatives. This committee has been making a study of the methods used in different fields of endeavor for presenting statistical and quantitative data in graphic form. It is evident that the graphic method permits the presentation of such figures and data with a great saving of time, and with more clearness than would otherwise be obtained. If simple and convenient standards can be found and made generally known, there will be possible a more universal use of graphic methods, with a consequent greater speed and accuracy with which complex information may be imparted and interpreted. The report lays down a number of fundamental principles that ought to be observed in elementary graphic presentation. Copies of the report may be had from the American Society of Mechanical Engineers, 29 W. 39th St., New York City, at a price of 10 cents.

Papers Read at Convention

A great number of papers were read at the various sessions, many of which dealt directly or indirectly with war conditions. Among those that had more direct bearing upon the war were "The Textile Industry in Relation to the War," by J. E. Rousmaniere; "The Small Industry in a Democracy," by George H. Haynes; "Converting a Factory for Munitions Manufacture," by John S. Holbrook; "Some Economic Aspects of Fire-protection Problems and Hazards in War Times," by J. Donald Pryor and Frank V. Sackett; and addresses on emergency technical war training, which were given in connection with the vocational training session.

The fuel problem is particularly pressing at this time, and there were two papers relating to this question: "Oil Fuel in New England Power Plants," by Henry W. Ballou, and "An Investigation of the Fuel Problem in the Middle West," by A. A. Potter. Two papers were contributed relating to safety education, one by L. A. De Blois, "The Safety Engineer," and one by George N. Follows, on "New Course of Instruction in Safety Work."

Efficiency of Gear Drives

A paper was read by C. M. Allen and F. W. Roys on "Efficiency of Gear Drives." The usual method employed in determining the efficiency of a gear drive is one in which the power loss is obtained by measuring the input and output and subtracting the latter from the former. In good drives, however, the efficiency is high and the input and output are very nearly equal, and any error in their measurement will result in a large percentage of error in their difference, or the power loss. It is, therefore, evident that a method by which the power loss may be directly measured will be much more accurate. The paper described such a method, developed recently in the Mechanical Engineering Laboratories of the Worcester Polytechnic Institute. In the apparatus used, an electric motor was so suspended in a cradle that both its armature and field were free to turn. The armature shaft was connected directly to the pinion gear shaft and the driven shaft directly to an Alden absorption dynamometer. The reaction of the motor field was balanced by the action of the dynamometer through a simple lever, the arms of which were accurately proportioned to the ratio of the gears. Results of tests on bevel-gear and worm-gear drives were given in tables and charts, and from the form of the curves presented and the consistency of the data, the conclusion was made that the method described is apparently the best yet devised for testing gear drives of all types.

Stresses in Machines when Starting and Stopping

A paper on the subject "Stresses in Machines when Starting or Stopping" was read by F. Hymans. For the intelligent determination of the dimensions of machine parts, it is necessary that the forces acting on them be known. The calculation of these forces follows at present one of two methods. The first assumes a state of equilibrium for the machine, which, however, exists only when the machine runs at constant speed or is at rest. In the second, the machine is considered to consist of rigid parts, but their acceleration at start or stop is considered. Neither of these methods leads to even approximately correct results. A new method for the correct evaluation of the forces acting on machine parts during start or stop is developed in this paper, and illustrated by application to a vertical geared hydraulic hoisting machine. It is shown that the stresses during start or stop depend on the inertia and elasticity of the parts, their distribution throughout the system, and on the magnitude and nature of the accelerating force. Vibrations at start or stop always occur, but whether they are pronounced and give rise to dangerous stresses depends to a very great extent on the character of the accelerating force.

Self-adjusting Spring Thrust Bearing

A paper on "A Self-adjusting Spring Thrust Bearing," by H. G. Reist, mentions how a careful study of the difficulties experienced with various types of thrust bearings used in supporting the heavy loads of water wheels and the electric generators driven by them, led the author to design the flexible bearing described in the paper. This bearing consists of a runner of a special grade of cast iron resting on a thin steel ring with a babbitted surface. The babbitted stationary ring, in turn, rests on a large number of short helical springs (ordinarily wound of ½-inch wire, 2 inches in diameter and 1½ inch long) and is held against rotation by dowel pins. A saw cut through one side does away with any tendency to dish with a change in temperature. This construction prevents the possibility of undue pressure at any point and compels each element of the surface to carry its share of the load.

Advantages to be derived from the use of such bearings are set forth, and figures are given showing a reduction in friction accompanying an increased unit pressure. Two designs are described and illustrated.

Elastic Indentation of Steel Balls under Pressure

A Paper on "The Elastic Indentation of Steel Balls under Pressure," by C. A. Briggs, W. C. Chapin, and H. G. Heil, reports the results of experiments recently carried out at the Bureau of Standards, Washington, D. C., in connection with the adjustment and standardization of precision apparatus in-

cident to the testing of munition gages. For the case of balls pressing against flat surfaces, which was the one considered in the experiments, the results obtained show that the indentation is not directly proportional to the pressure, but to the two-thirds power of the pressure. This is of importance in the design of ball bearings, as it indicates what effects are produced on the distribution of the load by slight variations in the size of the balls in a bearing. The results are given in the form of alignment charts and in metric and English units.

Fire-protection Problems in Factories

A paper was presented on "Some Economic Aspects of Fire-protection Problems and Hazards in War Times," by J. Donald Pryor and Frank V. Sackett, which pointed out the hazards involved at the present time in the war work of five great essential classes of industry, namely: metal-working; textile mills; shipyards; flour mills and grain elevators; and piers, wharfs, and docks. The engineering problems in connection with the adequate protection of such properties have to a large extent been solved, but the necessary safeguards are lacking, due either to a failure to grasp the necessity for such safeguards or else to economic conditions. Standard automatic-sprinkler protection is the most dependable means of safeguarding these various classes of risks, but in shipyards and piers that protection alone is not enough, but must be reinforced by hydrant systems, certain structural changes, and the organization and careful training of private fire brigades.

Other papers of interest presented were "A Foundry Cost and Accounting System," by William W. Bird; "The Public Interest as the Bed Rock of Professional Practice," by Morris L. Cooke; "Moisture Reabsorption of Air-dried Douglas Fir and Hard Pine, and the Effect on the Compressive Strengths," by Irving H. Cowdrey; "A High-speed Air and Gas Washer," by Lieutenant John L. Alden; "Investigation of the Uses of Steam in the Canning Factory," by Julian C. Smallwood; "Air Propulsion," by Morgan Brooks; and "Electric Heating of Molds," by Harold E. White. Copies of these papers may be obtained upon application to the American Society of Mechanical Engineers.

Workmen's Homes and Their Influence upon Production in the Factory and upon the Labor Turnover

Leslie H. Allen, of the Aberthaw Construction Co., Boston, Mass., read a paper on the influence of the workman's home upon production in the factory and upon the labor turnover, in which he stated that recent investigations have shown that one of the most important causes of the present abnormal labor turnover is the lack of sufficient homes for the population around industrial plants. A questionnaire, prepared and circulated by the company with which the author is connected, elicited 840 replies, from which many interesting and valuable extracts are given. From a study of these replies, the general impression is gained that the causes of the labor turnover today are improper or insufficient housing, inadequate transportation, the general restlessness usual in war times, and a lack of care in placing men in positions for which they are best fitted. One point that an investigation of housing conditions has brought out is that the type of house in which the workingman is generally lodged is not suited to his needs and is often beyond his earning power to support. Three- and four-room apartments and four- and five-room houses are an experimental type meeting with considerable success.

This paper was presented at the session held at the Norton Co.'s plant in Worcester. At this session addresses on the Norton Co.'s work relating to home developments for employes, their employment methods, training schools, and hospital service, were also read. The first of these subjects was dealt with by Clifford S. Anderson in a paper on "Indian Hill Development of the Norton Companies." The employment methods as followed by the Norton companies were explained by E. H. Fish, and J. C. Spence referred to the methods followed by the companies in the training of new employes in a paper entitled "Vestibule Schools," while Dr. W. Irving Clark gave a talk on the Norton hospital service. A lunch was served to members and guests of the American Society of Mechanical Engineers at the Norton Co.'s plant.

REPORT OF THE A. S. M. E. SCREW THREAD COMMITTEE

A report was presented at the spring meeting of the American Society of Mechanical Engineers held at Worcester, Mass., June 4 to 7, by the Committee on Limits and Tolerances in Screw Thread Fits, of which Luther D. Burlingame of the Brown & Sharpe Mfg. Co., Providence, R. I., is chairman. The following paragraphs contain a brief abstract of the general scope and methods followed by the committee in its work. The complete report, containing charts and tables of limits and tolerances, as well as illustrations of gages and measuring devices recommended by the committee, may be obtained from the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

The Committee on Limits and Tolerances in Screw Thread Fits was assigned by the council of the American Society of Mechanical Engineers the task "to prescribe the permissible tolerances in the commercial manufacture of taps, dies, bolts, nuts, and screws, including the method of measuring." During the years following the appointment of this committee, many meetings have been held, and work has been done through subcommittees, involving a great amount of investigation and study. Careful study has been given to data already published, and assistance has been secured from the U. S. Bureau of Standards, the Franklin Institute, the Navy Department, and from other sources. A request sent to many tap-makers for confidential information showing the limits allowed for their commercial work, led to a response by a number of leading manufacturers giving such information. This was tabulated and compared. Later, some of the tap-makers assisted by having over four thousand taps of commercial sizes from one-fourth inch to two inches, secured from a number of different makers, measured for errors in lead, in order to obtain the average variation of commercial taps which are in use today.

Early in the investigation, a meeting of screw manufacturers and users was called at the headquarters of the American Society of Mechanical Engineers in New York, at which about forty representatives were present, and the matter of tolerances and limits in screws was thoroughly discussed in the light of a tentative report which this committee had prepared. This meeting resulted in the appointment of a subcommittee to cooperate with the general committee by obtaining data from the screw manufacturers. Through this committee, and the officers of the American Society of Mechanical Engineers, over five thousand screws were obtained from the regular commercial stock of many different manufacturers, these representing work of various grades and sizes, and with cut and rolled threads. These screws were measured and the results tabulated. Sample screws and nuts were prepared having varying degrees of error in diameter and lead, and from these was determined the maximum allowable error, and charts were made to show the relation of taps and screws measured to these allowable limits.

Sample gages were also made to a closer limit than those now proposed by the committee, in order to learn how close it was practicable to make commercial work. These gages were distributed without stating what the allowance was in order that the users might not be prejudiced by thinking the limits were closer than they could work to. Comparisons have also been made with the allowances and tolerances recommended by the British Engineering Standards Committee, and the recommendations of the report are the outcome of all this study and investigation.

The study given to gaging systems led to the conclusion that no one system is best adapted to all needs; and that for a variety of work made in moderate quantities a gage for measuring errors of diameter and lead combined in the same instrument may give the best results, while for manufacturing in large quantities a fixed gage for one size only and having separate means for measuring errors in diameter and lead may be best. There is also the need in many cases of master gages, inspection gages, and workman's gages, each so made as to suit the particular needs. A number of designs of gages for these various purposes have been submitted to forty

prominent manufacturers and users, and following their recommendations selections have been made which are illustrated and described in the report.

Limits and Tolerances

It is believed that eventually three grades should be established to cover not only general work, such as is here provided, but also that of more restricted and more liberal tolerances. This report deals with limits and tolerances for general work only. Tables covering medium-grade work for general use have been prepared for diameters from one-fourth inch to two inches, but the formulas can be used for sizes beyond this range. They can also be used for different numbers of threads for a given diameter within ordinary range, provided the thread is of the U. S. standard form.

Generally stated, all tapped holes should be above basic standard and all screws, below; the more above or below in pitch diameter the greater the allowance possible in error of lead, while still maintaining a satisfactory fit.

* * *

WAR EMERGENCY COURSE ON EMPLOYMENT MANAGEMENT

Upon the outbreak of the war it became evident that the outcome of the conflict would depend upon a wise and efficient handling of labor in plants doing war work. The heads of the Industrial Service Sections of the Federal Departments, entrusted with the responsibility of formulating and administering correct labor policies, realized that there was a great lack of men trained in the art of labor management. It was decided, therefore, by these Industrial Service Departments, representing the Emergency Fleet Corporation, the Ordnance Department, the Quartermaster's Department, the Department of Labor, and the Navy, that short intensive courses should be established for the training of employment managers. The organization of such courses was undertaken by the Storage Committee of the War Industries Board. Captain Boyd Fisher of the Ordnance Department was put in charge of all these war emergency courses on employment management.

The first intensive course, from which twenty-four students were graduated, was started at the University of Rochester on March 26, 1918, under the direction of Professor Meyer Jacobstein. Another course was started at Boston on April 22, with Harvard University, Boston University, and Massachusetts Institute of Technology cooperating with the Boston Association of Employment Managers, under the direction of Professor Roy Kelly. The second course at Rochester was opened on June 3, with forty-three students.

The course consists of lectures, assigned readings, and visits to the large, well-organized plants of the city for observation and laboratory study. It requires the full time of the students for six consecutive weeks. Seven hours each day are scheduled for lectures and study, and, in addition, time will be required for notebook work and reading on assigned subjects. The topics covered in the first course are the treatment of absenteeism, tardiness, accidents, complaints, and grievances of employes; the direction of athletics and social activities, and the cooperative activities of employes; and the maintenance of discipline. Then are studied methods of hiring, including introduction of employes into business; the labor supply and insurance; relation of employment manager to management; lay-out of employment office; labor economics; medical examination; relation of employment department to outside agencies; personal service work; relation of employment manager to production; promotion of employes; records and statistics of employment office; safety work and safety organization; health of employes; specifications for jobs; suggestion system in plant; training and educating workers; transfer of employes; turnover of labor; union activities; wage systems; women in industry; workmen's compensation; industrial organization; and nature and use of statistics.

Qualifications for Admission

The authorities at Washington have stipulated that the applicant shall have had at least three to five years of good business experience and the equivalent of a high school education; he must also be a person with a strong personality, good initiative, resourcefulness, and a sympathetic understanding of the problems affecting the worker. It is moreover preferable that a person even with these qualifications be designated as a prospective employment manager by a firm engaged in war work, or designated by such a firm or a government department as its representative. The manufacturer or the government department so designating the student must agree to use him as an employment man upon completion of the course or some other satisfactory outcome of the work must be prearranged.

The course is open to women who have the prescribed qualifications. Participating in this course will not exempt a man of draft age from military duty, nor will a commission be given to graduates. Because of the intensive nature of the work, there are no evening courses, nor are there special summer or correspondence courses; persons enrolling must be present throughout the entire period of six weeks. There is every indication that there will be a large demand for competent employment managers and the Government will attempt to place people satisfactorily completing the course. It is, however, impossible to make definite promises to this effect.

It is becoming increasingly evident that a number of women and some men who wish to enter the field of employment management are fully qualified in all respects except industrial experience. It is the consensus of opinion that people who have had valuable experience in other fields, and even men and women who have had close contacts with industry from various angles but have never worked in a factory, need some experience in actual factory processes before they are adequately prepared for the six weeks' course in employment management. Women employment managers especially need this mechanical training because more and more women workers are going into the machine trades, and the proper selection and placement of workers depend largely on the employment manager's knowledge of mechanical processes. For this reason a two months' course in factory work under supervision will be offered in Pittsburg, Cleveland, or Detroit because of the large number of war contracts which the manufacturers of those cities have.

Official information and application blank for the course may be secured by addressing Captain Boyd Fisher, 717 Thirteenth St., Washington, D. C. The authority to enroll students in all War Emergency Courses on Employment Management and the passing upon the applicant's qualifications rest entirely with the government agencies at Washington.

* * *

WOMEN WORKERS IN FRENCH FACTORIES

As the employment of women in the various industries increases, much is being written of the results of the employment of women in England and France. Many of the writers, however, give widely different views; therefore an effort has been made by MACHINERY to learn the true conditions in France. Emile Chouanard[1] and George H. Brigham,[2] of Paris, in answer to inquiries sent them, state that one-third of the employes in French munition shops are women, while in shops engaged on light work they form about two-thirds of the force. In the Citroen and Delage plants they form 60 per cent of the force and in the Renault works, 30 per cent. In the Citroen factory, they are employed only in the manufacture of 75-millimeter shells; at the Renault factory the work is more general, comprising airplane engines, motor trucks, armored cars for machine guns, etc. In fact, they are employed in the various factories in inverse proportion to the heavy work done; that is, if the work is practically all hard and heavy, less women are employed. As a rule, women are not employed in shops handling heavy work, such as locomotives, for the pieces are too heavy for them to handle and the work requires well-trained mechanics.

Owing to the impossibility, during war time, of creating schools for their training, women workers in French factories had to receive their training in the shops. In the Citroen

[1] Care of Aux Forges de Vulcan, 3 Rue St. Denis, Paris, France.
[2] Address: 91 Rue de Maubeuge, Paris, France.

works, after an apprenticeship under the men, they are put directly on the machines; several women have gone into the tool-room and have become all-around machinists. In the Renault works, women are put directly on the machines with someone working with them until they become accustomed to the work; then they are left to themselves. Their wages are arranged during a period of fifteen days in such a way that if they do not become experienced enough to make a good day's wage on piece-work, they will still have enough to live on; if, at the end of that time it is seen that they will not make good on that particular work, they are changed to other work. In most factories women begin with the simplest work and run ordinary lathes without any training. Some of the more skillful are soon able to run other machines.

In the Citroen works, women are employed on inspection, and also work on automatic or semi-automatic machines tooled by experienced men. In the Renault works, women are employed on all kinds of work-adjusting, setting up, inspection, work on automatics, semi-automatics, etc. Some are grinding cylinders, work that requires much skill, while others are grinding valves. In the tool-room, some women are making taps and dies, while others are employed simply as operators, running machines that have been tooled by men.

While the number of accidents has been reduced with the employment of women, this is due considerably to the larger use of safeguards by the manufacturers. In the Citroen works, however, the proportion of accidents has remained practically the same. In the Renault works, as about 30 per cent of the employes are women and about 30 per cent of the cases given first-aid are women, apparently the proportion of accidents has not increased.

Wages and Output

The women come from all sorts of occupations and many have never worked in factories before. Some were maids, others were cooks and shop attendants of all kinds, and a large number were the wives or daughters of mechanics. As a rule, the women improve rapidly in their work, and when on piece-work make considerable progress and good wages. They prove most useful in work requiring dexterity and skill. In the Citroen works, they are given the same pay as the men for the same work. In the Renault works, even in the tool-room, they are not paid quite the same wages as the men; care is taken to keep women on light work, and all the heavier work is done by unskilled male labor. As a rule, in the munition factories, the average woman's earnings are three-fourths of a man's. In some cases, particularly at the beginning, some women produced more than the men, perhaps on account of a spirit of rivalry, but it was found that they could not maintain this speed. Many became ill from fatigue and were forced to take a rest; when they resumed their work, the production was lower. In general, the women belong to the same union as the men.

Opinion of Employers as to Efficiency of Women

Manufacturers differ greatly in their opinions of the efficiency of women employes, and the opinions seem to vary according to districts. Some manufacturers, like André Citroen, say that they are well pleased with the results produced by the women, while others are eagerly awaiting the end of the war when they will have their male mechanics back again. They seem to be more satisfied with repetition work than the men, but, on the other hand, are less stable. If they do not feel quite well they do not come to work when a man would. During a certain period when observations were taken, there was an efficiency among the men of 90 per cent of the total number of machine hours, while the women showed only 75 per cent.

In many cases, the hours of work have had to be altered; at first they were about the same as for the men, but later they had to be reduced. Many lifting devices also had to be designed to make the work less laborious, especially in the case of handling shells on a lathe. In the Citroen works slight modifications have been made on the machines to help in tightening up chucks, but as the work is entirely on the 75-millimeter shells, no further modifications were necessary.

PRIORITY ORDERS FOR STEEL

In order to preserve the nation's steel supply, and to prevent the use of steel in industries that are non-essential to the winning of the war, the Government has made a ruling that no steel is to be furnished by the steel mills to manufacturers or dealers except upon presentation of a priority order. If this ruling is to be literally interpreted, it will cause a great deal of difficulty in many industries that produce materials directly or indirectly necessary in the conduct of the war; and the machine tool industry would especially be hampered in its production, delays in filling orders would be inevitable, the clerical work of keeping track of hundreds, and perhaps thousands, of priority orders, as in the small tool industry, would be greatly increased, and instead of aiding in winning the war by conservation, the new ruling would hamper its prosecution by slowing up production.

It is therefore to be expected that modifications in the ruling will be made to suit certain absolutely essential industries, like the machine tool industry. In this industry, practically all work now done is for war materials—directly or indirectly. One manufacturer reports over 90 per cent of all his work to be war work directly, and of the remainder, it is likely that a large percentage is indirectly used in the production of war materials. Another manufacturer reports 95 per cent, and still another 98 per cent of his work to be war work.

In view of these facts, it has been suggested that machine tool builders and makers of tools who can show so large a percentage of war work be exempted from the literal interpretation of the steel priorities order, and that some blanket priority order be issued to the machine tool and small tool manufacturers that would cover all their requirements. The steel jobbers and dealers who supply manufacturers of this kind should also be assured that when they fill orders on these blanket priority orders, they may replenish their stock from the mills without other formality than a statement of the order number for which the steel was supplied.

The Cleveland Twist Drill Co., Cleveland, Ohio, makes the following specific suggestions with regard to this subject, and if, upon the publication of this article, the Government has not yet modified the details of the ruling to meet the necessary demands of the machine and tool industries, manufacturers generally ought to forward to the Priorities Board at Washington similar suggestions. The suggestions of the Cleveland Twist Drill Co. are, in substance, as follows:

> The description of essential and non-essential industries is not fully or well defined at this time. Until they are generally understood, it would be of material assistance, and would reduce clerical work to a minimum, if the Government would issue a Manufacturer's Priority License, or, in other words, a license issued to manufacturers of essential war material, machinery, and tools, for securing factory supplies. The number and symbol of such license or certificate should be used on order blanks to assure the recipient, without further investigation, that the Government recognizes the firm ordering the supplies as a bona fide war material manufacturer, and that, therefore, this order is entitled to all possible consideration. Such a stamp of approval could be made to carry with it a penalty for offense if used for any other than a legitimate purpose.
>
> For operating a plant and manufacturing machine and tool products, thousands of different items are essential, and it would be a criminal negligence on the part of the machine industry if the industry would not endeavor to secure recognition of the Government, enabling manufacturers to receive without unnecessary delay such articles as are necessary to carry on their business.

It certainly would greatly facilitate the speeding up of the production of war materials if, in this way, a whole manufacturing plant, engaged principally on war work, could be given a single blanket priority order; the delay incident to securing and handling hundreds of separate priority orders is unwarranted. What we want is simply an assurance that whatever steel a manufacturer receives is used for a purpose essential to the prosecution of the war; after that, cut the red tape to a minimum and let us speed up for victory.

* * *

According to the *Iron and Coal Trades Review*, of London, Great Britain has increased its output of steel from 7,800,000 tons in 1914 to about 11,000,000 tons in 1917; on the present basis, the output will reach 12,000,000 tons this year.

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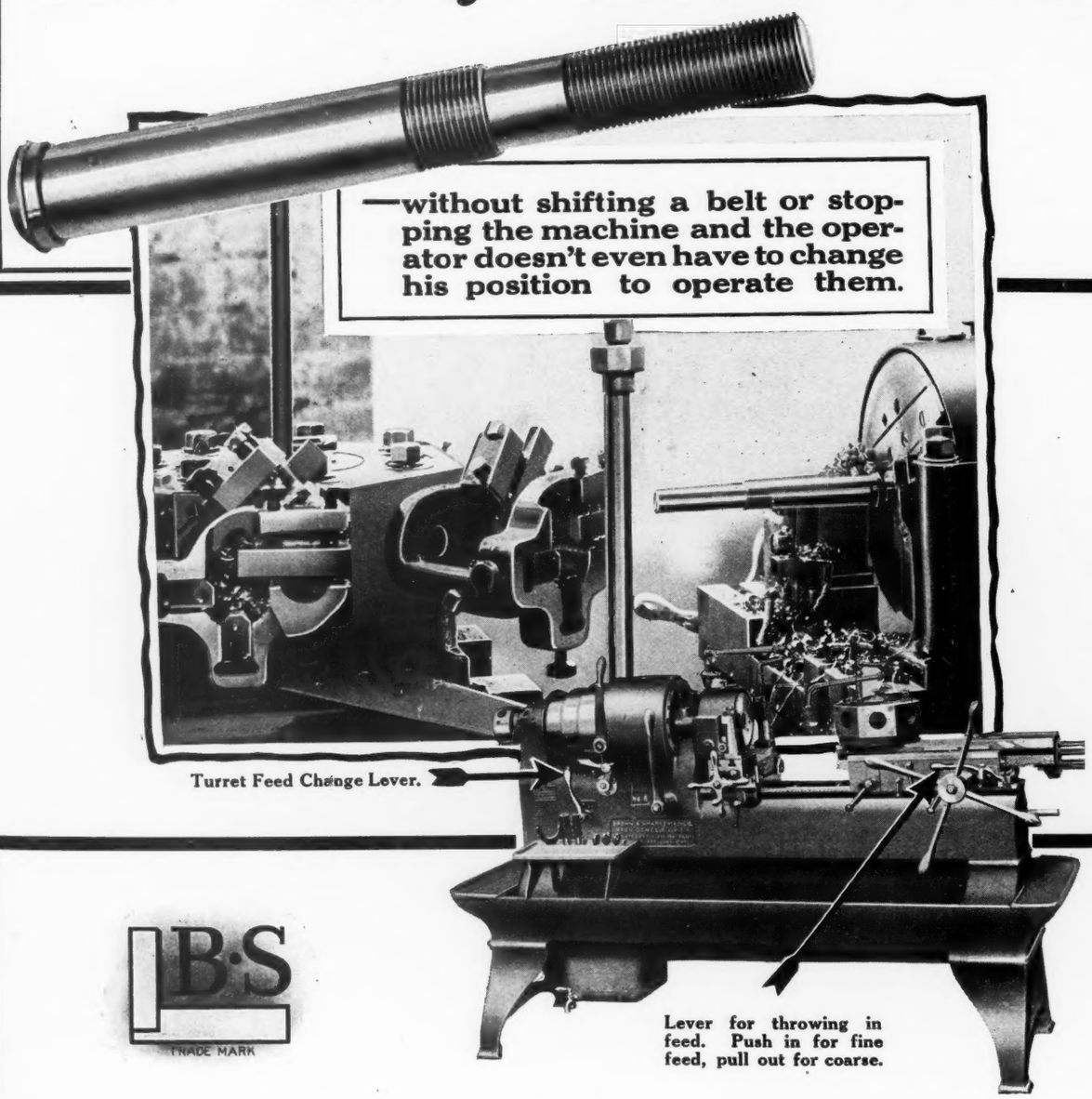

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HELPING UNCLE SAM

An organization has been formed by the workers in one of the departments of the Scovill Mfg. Co., Waterbury, Conn., known as the "Building No. 99 Club," the requirements for members of which are as follows: Fear God, hate Prussianism, and work or fight to beat the German Empire. Buy at least one War Stamp a week, a bond at each issue, and stand ready to serve in any capacity demanded by the Government.

The Naval Reserve Force desires to enroll at once one thousand men experienced in the operation and maintenance of gas and gasoline engines. These men are required for immediate duty and will be rated as machinist's mates. The age limits are from eighteen to thirty-five years. The applicants must be American citizens. Draft registrants with letters from their local boards will be accepted. Applicants should apply at the Naval Reserve enrolling office, 51 Chambers St., New York City, or at any Navy recruiting station.

The Government is in need of a number of mechanical laboratory assistants and draftsmen for important war work in the development of parts from sheet metal, fabric, and rubber. Graduates from manual training schools with one or two years' shop experience, or men with one or two years in an engineering school are desirable, and the pay is dependent upon ability and experience. Applicants should communicate with B. B. Fogler, mechanical engineer in charge of the Mechanical Research and Development Division, Army Defense Problems, American University, Washington, D. C. It is requested that applicants send a photograph and state their age, reference, positions in the draft, and willingness to enlist or be inducted in the army for work of this nature if necessary.

According to a statement made by Major Mark L. Ireland, Quartermaster Corps, U. S. A., who is in command of the extensive automobile repair shops at Fort Sam Houston, Texas, the great need in the present war is motor transportation, and the greatest problem arising in connection with motor transportation is to keep it available at all times for service. In order to accomplish this the Government is in actual need of hundreds of automobile mechanics and men possessing qualifications for automobile repair work. The most urgent need at the present time is for men having experience in the following trades: General automobile repair, battery repair, blacksmithing, and sheet metal work. In addition, machinists and machinists' helpers, motor vehicle inspectors, magneto repair men, and oxy-acetylene and electric welders are required. Any man, whether in the draft age or otherwise, who has had experience along the lines above indicated, is requested to write without delay to the Commanding Officer of Quartermaster Mechanical Repair Shop, No. 304, Fort Sam Houston, Texas, who will furnish full particulars concerning pay, and other subject matter indicating opportunities that are open to men possessing qualifications making them desirable for duty with this organization.

The United States Army requires 2000 additional engineering officers. The age limits for the first grade of lieutenant are from thirty-two to thirty-six years of age, and for captain, thirty-six to forty-two years. These limits may be slightly increased or decreased in special cases, but no one within the draft age will be considered. The applicants must be engaged in the active practice of the engineering profession and be in good physical health. The fitness for commission of all applicants will be passed upon by an examining board. Applicants must be citizens of the United States, but no application will be considered from anyone now in the government service, nor will applications be considered from anyone born in a country with which the United States is at war, or born in a country allied with a country with which the United States is at war, even though he may be a naturalized citizen of this country. Requests for application blanks should be made in writing to the Chief of Engineers, United States Army, Washington, D. C. All applicants accepted by the examining board will be commissioned within ten days or two weeks and will receive orders to report at an engineer officers' training camp, where he will be given a course in military training previous to being assigned to duty with the engineer troops.

The Secretary of the Treasury says, "The releasing of labor and materials from the pursuits of peace to the business of war is one of the necessities of our war program if we are to put our whole strength behind our men in France." This is a call to the machinists and mechanics of America engaged in the manufacture of non-essentials, to perform the highest form of service possible back of the firing lines. The government arsenals must have skilled workmen to man the ever-growing equipment called for by the needs of the ever-growing army.

This service is not in the nature of sacrifice, for the Government pays good wages for work performed under the best conditions. At the Watervliet Arsenal, Watervliet, N. Y., the housing problem is solved by a special department which devotes its entire time to securing suitable homes for its new workmen. Situated on the Hudson River, opposite Troy, and only a few miles from Albany, this arsenal offers unusual advantages to the man with a family, as it is in close proximity to good schools, libraries, churches, places of amusement, and has a moderate cost of living.

Get behind the men behind the guns! If you are running a machine anywhere that does not produce some tool, device, or material necessary to the conduct of the war, offer your skill to your country. Applications should be directed, in writing, to the Commanding Officer, Watervliet Arsenal, Watervliet, N. Y.

* * *

STANDARD SIZES OF CATALOGUES FOR PURCHASING AGENTS

The National Catalogue Conference, held at Chicago in May, recommended that catalogues be standardized to 6 by 9, 7½ by 10⅝, or 8 by 11 inches. The standardization committee of the National Association of Purchasing Agents asks that all catalogues intended for purchasing agents be made 7½ by 10⅝ inches, or one-half this size, provided they are saddle stitched, so that when opened, in filing, they will measure 7½ by 10⅝ inches. Single sheets, such as blueprints, will be filed in the purchasing agent's standard file provided they may readily be folded to the standard size. Pamphlets of the standard size may be folded for convenience in mailing, but should be so made as to permit easy unfolding and filing by the purchasing agent. The committee also recommends that paper for catalogues be confined to weights, based on the 25- by 38-inch size, of 40, 45, 50, 60, 70, and 80 pounds, and that colors be restricted to white and natural.

* * *

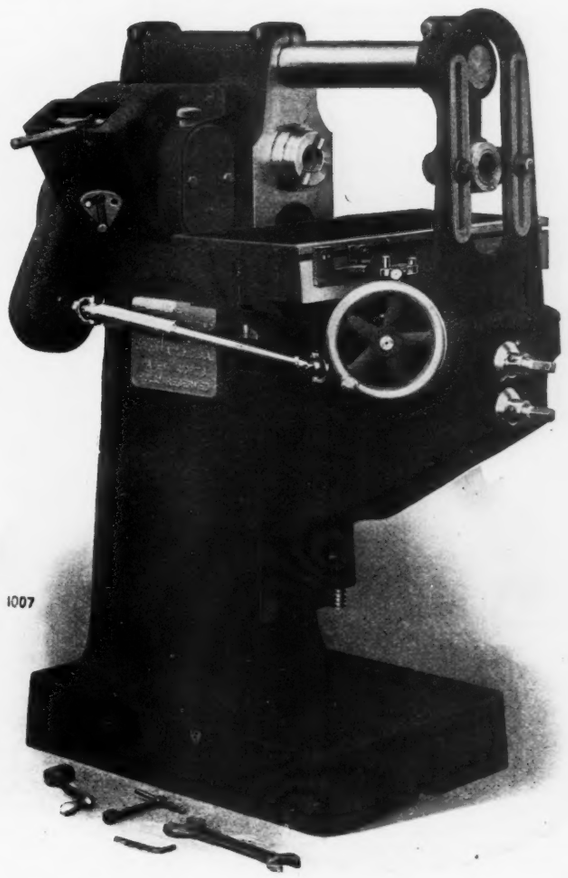
According to the reports of the deans and presidents of 150 colleges and universities with women students, girls' colleges are now reorganizing to meet the war emergency. Usually the war courses are given in the time formerly devoted to recreation; no student is allowed to elect more than one, and no student can be enrolled unless her work is up to the regular standard. The special courses are: telegraphy, wireless telegraphy, automobile mechanics, nautical astronomy, navigation, elementary nursing, first-aid, principles of war relief, drafting, medical laboratory methods, map drawing, home economics (dietetics, conservation of food, training for work in cafeterias, and soup kitchens), industrial chemistry, farm management, surgical dressings, office routine (all business training for office work), and a course for teachers in occupational therapy.

* * *

The Manufacturers' Association of Connecticut has issued a thirty-page pamphlet called "Our Job," which contains portions of President Wilson's address in Buffalo, 1917, on the test of a true American, with a statement of why America is at war and an appeal for loyalty. The pamphlet is printed in English, Lithuanian, Polish, Russian, German, and Italian.

The New Cincinnati 12" Knee Type Manufacturing Miller for Repetition Work

Arms manufacturing plants and any other shops turning out great quantities of small parts will find this machine intensely profitable. Capable of standing up to the drive of twenty-four hours a day service, and giving maximum production at all times. It is compact, having only 12" table travel. It is powerful—4 h.p. at the spindle. The drive is by constant speed belt, with a commercial range of feeds and speeds, and for the sake of simplicity, quick change mechanisms have been avoided, the change in feed or speed being made by interposing change gears.



The Cincinnati 12-inch Knee Type Manufacturing Miller.
(Patent Rights Fully Reserved)
Single Pulley Drive—4 H.P.—Twelve speeds—Four feeds.

It Is Handy

The operator stands at the end of the table. Assume that a new piece has been chucked: He runs the table forward with his right hand at 2¾" per turn of the hand wheel. A dog hits the trip, which automatically disengages the hand movement, and at the same time throws in the power feed. When the piece has been milled, another dog disengages the power feed, and the operator brings the table back by hand, ready to chuck a new piece. *This is quick action. The operator can slam the table forward as fast as he pleases without danger of jamming the work into the cutter.* The trip dog takes care of that, and it can be set so that the work will be close up to the cutter before the power feed engages, thus reducing the power travel of the work to a minimum.

Ask for Complete Specifications

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO, U. S. A.

OBITUARIES

HENRY WARE CLARKE

Lieutenant Henry Ware Clarke, son of Charles A. Clarke of Hill, Clarke & Co. and Georgiania W. Clarke, was killed in action in France on May 29. Lieutenant Clarke was born in Chicago, where his parents then resided, on November 19, 1893, and returned with them to Newton, Mass., when he was two years old. He was educated in the public schools of that town and entered Harvard College, graduating in the class of 1916.

Lieutenant Clarke went to Plattsburg in 1916-1917, and was commissioned from there as Second Lieutenant, volunteering at once for active service in France, where he arrived in September, 1917, and began training with different units, being finally assigned to the 16th Regiment, Regular Army, Machine Gun Company. In April of this year he received an honor chevron for six months' service in the front zone. As his record shows, Lieutenant Clarke was one of the first to respond to the call of duty, inspired with that devotion to high and noble ideals which has characterized the youth of our country in her hour of need.

Lieutenant Clarke was a member of the Doric Masonic Lodge of Hudson, Mass. After leaving Harvard he became associated with his father in the manufacturing business of the Universal Boring Machine Co. of Hudson.

LESLIE H. COLBURN

Leslie H. Colburn, general manager of the Colburn Machine Tool Co., Franklin, Pa., died at his home in that city May 26. He was born in Fitchburg, Mass., in 1867, and was the second son of Henry J. and Eliza A. Colburn. When fifteen years of age, he went with his father to Toledo and after two years in the Toledo High School started to work in the shops of Baker Bros., and there learned the machinists' trade. While working at his trade, he designed and built two marine engines, one of which was in use for several years on his steam yacht *Rambler*. Mr. Colburn assisted his father in developing many of the latter's inventions, and when his father resigned as superintendent of the plant of Baker Bros., he was selected to fill this position. Leslie H. Colburn served Baker Bros. at various times in the capacity of designer and production and sales manager, and has to his credit a number of valuable patents on machine tools which he took out while with this firm. He invented the Colburn keyway cutter, which was built by the Baker Bros., and which had a large sale in this and foreign countries. He next developed a high-speed heavy-duty drilling machine for use in drilling bicycle, automobile, and harvesting machinery parts. While superintendent of Baker Bros. the business grew so rapidly that it became necessary to build a large modern foundry and machine shop which was located in an undeveloped section of Toledo, now in the center of the manufacturing district. In 1901, he left this position and went to Franklin, Pa., where he founded the Colburn Machine Tool Co. As general manager of the Colburn Machine Tool Co., Mr. Colburn supervised the bringing out of a number of new machines, including a universal saw table designed and patented by his father, Henry J. Colburn, a draw-stroke vertical shaper, a vertical boring mill, and a high-speed heavy-duty drilling machine. The boring mill and the drilling machine met with such success that the universal saw table and the draw-stroke shaper were discontinued. Mr. Colburn gave close attention to details, and always considered that the successful solution of any problem required the utmost care in the development of smaller as well as larger factors.

In 1892, Mr. Colburn married Leora I. Westbrook, of Detroit, Mich., who survives him. He is also survived by three brothers, Charles B. Colburn of Franklin, Pa., George L. Colburn, general manager of the Colburn Gear & Mfg. Co., Boston, Mass., and Harrison S. Colburn, president of the Harrison S. Colburn Real Estate Co., New York City.

Although in poor health for several years, Mr. Colburn took great interest in the various activities of Franklin, in which his business was located, and was one of the first men to urge better housing facilities for the working men of the community. He was a man of strong personality, and his passing away is deeply regretted by those who knew him.

PERSONALS

J. B. FITZGIBBON, treasurer of the Anderson Die Machine Co., Bridgeport, Conn., has resigned his position with that company.

E. P. ESSLEY was made secretary of the E. L. Essley Machinery Co., Chicago, Ill., machine tool dealer, at a recent meeting of the company.

WALTER E. BUSH, 109 Highland Ave., Jersey City, N. J., has recently been appointed United States buyer for one of the largest importing corporations in Australia.

W. A. VIALL, secretary of the Brown & Sharpe Mfg. Co., Providence, R. I., has had the honorary degree of Master of Arts conferred upon him by Brown University.

R. W. ELLINGHAM, formerly factory manager of the Bilton Machine Tool Co., Bridgeport, Conn., is now connected with the Heald Machine Co., of Worcester, Mass., in a similar capacity.

E. J. EDWARDS, formerly assistant chemist and engineer of tests with the American Locomotive Co., has been appointed engineer of tests with that company, with headquarters in Schenectady.

HERMAN WEYRAUCH, formerly superintendent of the American Spray Co.'s Works at Elizabeth, N. J., is now employed in the Ordnance Department, U. S. Army, Gage Section, New York District Office.

L. F. MULHOLLAND, local chemist and engineer of tests of the Richmond Works, has recently been appointed assistant engineer of tests of the American Locomotive Co., with headquarters in Schenectady.

E. F. LAKE has been made superintendent of the Rich Tool Department of the American Car & Foundry Co., Chicago, Ill. William R. Man, who formerly held this position, has started a manufacturing plant of his own.

D. P. BROWN, formerly of the Bryant Chucking Grinder Co., Detroit, Mich., has now become associated with the Hendey Machine Co., and is in charge of this company's office in Rochester, N. Y., Chamber of Commerce Bldg.

S. R. HUNTER has recently become associated with the American Rolling Co. of Middletown, Ohio, as production superintendent. He was formerly superintendent of the Gas Engine Department of the Fairbanks, Morse Co., Beloit, Wis.

CHARLES A. MCCUNE, formerly chief engineer of the Commercial Acetylene Co., has become associated with the Page Steel & Wire Co., 30 Church St., New York City, as sales engineer, and will devote his time to the sales of "Armco" welding rods.

F. J. KIDD, for six years with the Racine Mfg. Co., and former treasurer of the Corliss Mfg. Co., has been made manager and assistant treasurer of the Racine Tool & Machine Co., of Racine, Wis., manufacturer of high-speed cutting-off saws.

ARTHUR B. BABBITT, for the past six years head of the Department of Drawing and Design, at Wentworth Institute, Boston, Mass., has resigned that position and has given up his private engineering practice to become general manager of the Kent Machine Co., Kent, Ohio.

FRANK WOLLAEGER, JR., secretary of the Kempsmith Mfg. Co., Milwaukee, Wis., who enlisted in the Milwaukee Base Hospital Unit, has been transferred to the Ordnance Department and has been sent to Camp Hancock, Augusta, Ga., to take special training for his work in this department.

V. P. SIGNORELLI, formerly secretary and assistant treasurer of the Southwark Foundry & Machine Co., Philadelphia, Pa., is now office manager and auditor of the Foundation Company-Carpenter-Watkins, Inc., Brunswick, Ga. The previous announcement concerning the change of Mr. Signorelli's position, published in the June number of MACHINERY, was in error.

The LUCAS

(OF CLEVELAND)

"PRECISION"

BORING, DRILLING AND

MILLING MACHINE

ALWAYS GOOD

and as time goes on

ALWAYS BETTER

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

R. McA. KEOWN, associate professor of machine design in the University of Wisconsin, has been appointed engineer of the Industrial Commission of Wisconsin, Madison, Wis., in charge of the Department of Safety and Sanitation, succeeding Sidney J. Williams, who resigned to become manager of the Accident Prevention Department of the National Safety Council.

J. E. PARKER, formerly efficiency engineer with the Cincinnati-Bickford Tool Co., Cincinnati, Ohio, has become factory manager of the Spencer-Smith Machine Co., Howell, Mich., which manufactures automotive pistons exclusively. The Spencer-Smith Machine Co. is installing new equipment in order to facilitate a greater production of pistons for government aircraft.

JULIUS ALSBERG has opened a consulting engineering office in Room 1526, Tribune Bldg., 7 S. Dearborn St., Chicago, Ill., and will specialize in power plant work and efficiency work in connection with power plants, lay-outs of industrial and chemical plants, the study of industrial and chemical problems in connection with industries, and efficiency work generally in connection with these lines.

WILLIAM R. TOMLINSON, who was for many years superintendent and for the past year vice-president and works manager of the Billings & Spencer Co., Hartford, Conn., is now works manager of the Pratt & Whitney Co., of the same city. Mr. Tomlinson served his apprenticeship with the Pratt & Whitney Co. some twenty years ago, and after an extensive experience elsewhere, now returns to the company as head of the mechanical departments.

F. O. HOAGLAND has left his position as works manager of the Pratt & Whitney Co., Hartford, Conn., and is now vice-president and works manager of the Bilton Machine Tool Co., Bridgeport, Conn. He will remain on the staff of the Pratt & Whitney Co., however, in a consulting capacity. Previous to coming to the Pratt & Whitney Co., Mr. Hoagland was for several years works manager of the Union Metallic Cartridge Co., Bridgeport, Conn., and at an earlier time chief engineer of the Remington Arms Co., Ilion, N. Y.

C. E. CARPENTER, of the Paris office of the Allied Machinery Co. of America, 120 Broadway, New York City, has been requested by officers of the American Expeditionary Forces in France to accept a commission as captain in the United States Army, Quartermasters Department, and has complied with the request, since the Allied Machinery Co., for patriotic reasons, had declared itself willing to release him. Mr. Hartridge, manager of the New York office, and Mr. McKay, also of the Allied Machinery Co., have sailed for France to obtain first-hand information relating to the machinery situation there, and to confer with Mr. Carpenter in regard to the procedure to follow during the duration of the war. Mr. Hartridge and Mr. McKay will return within three or four months.

COMING EVENTS

July 25—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

September 10—Twenty-sixth annual convention of the Traveling Engineers' Association, in Chicago, Ill. Secretary, W. O. Thompson, General Offices, New York Central Railroad, Cleveland, Ohio.

October 7-12—Joint convention of the American Foundrymen's Association and the American Institute of Metals in Milwaukee, Wis. Concurrent with these meetings there will be an exhibition of foundry equipment, machine tools, and accessories.

SOCIETIES, SCHOOLS AND COLLEGES

Detroit Technical Institute has changed its name to Detroit Institute of Technology and has appointed Benjamin D. Edwards chancellor.

Lowell Textile School, Lowell, Mass. Catalogue for 1918-1919, containing calendar, synopsis of courses, and other information relating to the work of the school.

University of Arizona, College of Mines and Engineering, Tucson, Ariz. Pamphlets entitled "Mining Engineering as a Profession," "Electrical Engineering as a Profession," "Civil Engineering as a Profession," and "Mechanical Engineering as a Profession," containing an outline of the advantages offered to students of the university in these courses, necessary qualifications, opportunities, and pay.

University of Illinois, College of Engineering and Engineering Experiment Station, Urbana, Ill., announces special advanced courses in the mechanics and properties of materials of construction, and in materials testing, to be given at the university in the summer session beginning June 17 and ending August 9. These courses constitute an intensive training for men who desire to qualify as testing engineers in the government service or in the service of manufacturing companies. The courses offer an excellent opportunity for advanced work in mechanics and in materials testing to instructors who wish to familiarize themselves with the latest methods of instruction in such work. Further information concerning the courses may be obtained from the Director of the Summer Session, University of Illinois, Urbana, Ill.

NEW BOOKS AND PAMPHLETS

Mineral Waters in 1916. By Arthur J. Ellis. 47 pages, 6 by 9 inches. Published by the Department of the Interior, Washington, D. C.

Gold, Silver, Copper, Lead, and Zinc in Idaho and Washington in 1916. By C. N. Gerry. 51 pages, 6 by 9 inches. Published by the Department of the Interior, Washington, D. C.

The Storage of Bituminous Coal. By H. H. Stoek. 192 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Circular No. 6.

Fuel Economy in the Operation of Hand-fired Power Plants. 89 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Circular No. 7.

Legal Weights (in Pounds) per Bushel of Various Commodities. 20 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 10 of the Bureau of Standards. Price, 5 cents.

Electric Pumping, with Results of Tests and Operating Records. By H. W. Wagner. 80 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin No. 46.

Standard Cotton Mill Practice and Equipment. 204 pages, 6 by 9 inches. Published by the National Association of Cotton Manufacturers, 45 Milk St., Boston, Mass. Price, $1.50.

This is the first number of a publication which is to be published annually. It contains a review of the cotton trade in 1917, statistical tables relating to raw cotton, technical tables used in the industry, engineering data, and a buyer's index, which is a list of the best-known manufacturers of supplies used in textile mills.

Trade Specifications and Occupational Index. 240 pages, 6 by 9 inches. Published by the United States War Department, Washington, D. C.

The purpose of this manual is to standardize vocational terminology in the United States Army and to define the duties of specialists and skilled tradesmen required by its various technical organizations. In each case it gives first the duties to be performed, then the qualifications of a well-trained high-grade man or all-around journeyman, and last the nearest equivalent or substitute occupations that may be drawn upon as a source of supply if necessary. At the head of each paragraph is the standard occupational name and symbol used by the Adjutant General's office and a code or index word that may be used when telegraphing. Suitable indexes are provided for ready reference and location of the proper specification for any trade.

The Model T Ford Car; its Construction, Operation, and Repair. By Victor W. Page. 310 pages, 5 by 7 inches; 106 illustrations and two large folding plates. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $1.

In this book all parts of the Model T car and Ford tractor are described and illustrated by specially made drawings and photographs. The construction is fully treated and the operating principle is made clear. Especial attention is paid to the various attachments to the chassis by which it may be converted into a truck or tractor. The book is limited to the Ford cars as produced by the factory, and no attempt has been made to describe the many accessories offered for these cars, such as self-starters, lighting regulators, etc. As practically no mechanical changes have been made in the 1918 car, the instructions are as applicable to the newer as to the older cars. The six chapters are headed as follows: The Ford Car, Its Parts and Their Functions; The Engine and Auxiliary Groups; Details of the Ford Chassis Parts; Driving and Maintenance of Ford Cars; Overhauling and Repairing Mechanism; The Ford Tractor and Tractor Conversion Sets and Genuine Ford Tractor.

Bookkeeping and Cost Accounting for Factories. By William Kent. 258 pages, 8 by 11 inches; numerous illustrations, charts, and tables. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $4.

The author of this work, who was a bookkeeper and cost accountant for some years before he became an engineer and who, during his engineering experience, has had several occasions to install systems of bookkeeping and cost accounting and to audit books, has undertaken to prepare a systematic treatise on cost accounting which will start the student at the beginning with the elementary principles of double-entry bookkeeping and lead him through factory accounting to cost accounting. The work is a very comprehensive one, containing examples of methods of accounting and cost keeping in the form of tables, charts, sample pages of account books, etc. It is divided into twenty-one chapters, the headings of which indicate the scope of the work: Bookkeeping; Titles and Definitions of Accounts; The Evolution of Bookkeeping—The Column Ledger; Accounts for Retail Merchants, Selling Prices—Turnover; Factory Accounting; Cost Accounting; Cost Finding Methods—Use of the Job Ticket; Distribution of Burden; Depreciation—Inventory Valuation—Appraisals; Systems and Red Tape—Fundamentals of a Cost System; Daily and Monthly Records—Charting of Statistics—Cost of Idleness; Problems and Difficulties—Standard Cost; Uses of Costs—Various Opinions about Costs; Classification—Symbols—Bookkeeping by Machinery; Old-school Accounting; Iron Works Bookkeeping; Modern Accounting Systems for Steel Works; Foundry Costs—Cost of Coal; Hardware Factory and Machine Shop Accounting; Costs in a Woodworking Shop—A Bakery—A Textile Mill—A Power Plant; Costs in a Printing Shop; Reports to Stockholders—Education of Accountants—Cost of Idleness—Miscellaneous Forms—Bibliography. To anyone who has to do with factory cost accounting, the work should prove a most valuable manual, as it lays down fundamental theory in accordance with the views of the ablest modern accountants, and also warns against the time-worn methods of the older school which do not meet present-day requirements.

Elements of Machine Design. By Henry L. Nachman. 245 pages, 6 by 9 inches; numerous illustrations. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $2.

This book has been written primarily as a textbook for engineering schools and colleges, and comprises a course in elementary machine design. It is the result of the author's experience extending over more than fifteen years, both in practical design and in the teaching of this subject in the capacity of associate professor of kinematics and machine design at the Armour Institute of Technology, Chicago, Ill. Considering the comparatively brief space in which the subject is covered, the work is remarkably well done, because it contains a great deal of information in a compact and yet readable form. Of course, the theoretical side of machine design has been mainly emphasized, the major portions of the work being devoted to working formulas for determining stresses in, and dimensions of, machine details. The illustrations appear to have been carefully chosen to show typical constructions, but, on account of the limited space, a great variety of designs evidently could not be shown. Each chapter ends with a number of problems suitable for solution by the students. The range of the subjects dealt with in the work is best indicated by a review of the chapter heads, which are as follows: Strength of Materials; Screw Fastenings; Riveted Joints; Keys and Cotters; Shrink and Force Fits; Shafts and Axles; Couplings and Clutches; Journals and Bearings; Belts and Pulleys; Friction Wheels; Toothed Gears; Rope Transmission; Chain Gearing; Pipes and Cylinders; Valves; Flywheels; Crankshafts, Crankpins, and Eccentrics; Connecting-rods, Piston-rods, and Eccentric Rods; Pistons, Crossheads, and Stuffing-boxes; Hoisting Machinery Details; Springs; Materials of Machinery. While it is evident that the book does not give enough information on any one of these subjects to a designer who wishes to make a detailed study of one particular branch of machine design, it is a work that can be recommended for the class-room use for which it is prepared. It will give the student an excellent perspective of the subject of machine design and will aid him in obtaining facility in analyzing forces and resultant stresses in machine parts, and in applying proper methods and formulas in their design.

NEW CATALOGUES AND CIRCULARS

Buffalo Forge Co., Buffalo, N. Y. Catalogue 108, of stationary forges, giving dimensions and prices.

Peck, Stow & Wilcox Co., Southington, Conn. Catalogue of sheet metal worker's machines and tools.

Oliver Machinery Co., Grand Rapids, Mich. Circular descriptive of Oliver No. 52 motor-head face lathe.

National Tube Co., Pittsburg, Pa. Circular entitled "The Identifying Mark," advertising National pipe.

National Woodworking Machine Co., Dover, N. H. Bulletin 1 describing a new profile and bevel planer for woodworking.